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SUMMARY OF INSECT CONDITIONS THROUGHOUT THE UNITED STATES DURING 1921.

By J. A. Hyslop, *Entomologist in Charge, Insect Pest Survey, Bureau of Entomology.*

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INTRODUCTION.

The object of the insect-pest survey is to collect accurate and detailed information on the occurrence, distribution, ecology, and relative destructiveness of insect pests throughout the United States, and to study this data from month to month and year to year with relation to the several factors that influence insect abundance. The results to be obtained from this undertaking over a series of years are manifold; we should be able to throw light on the reasons for the cyclic appearance of certain insect pests, the gradual shift of regions of destructive abundance, the limiting barriers to normal dispersal, the directive influences that determine the paths of insect diffusion, and the relation of climatology, geography, topography, and geology, as well as biological complexes, to insect distribution and abundance. This is the necessary foundation for the next advance step in economic entomology, *entomological forecasting.*

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The data upon which these summaries are based were collected during the growing season by collaborators, including the field workers of the Bureau of Entomology. Where the review of an insect was drawn largely from the general files of collaborators' reports, no special credit is given in the annual summary. Where the review was drawn from the reports of one or a few workers, acknowledgement is made in footnotes.

Weather data were tabulated, graphically presented, and correlated with the various insect outbreaks by the survey. In these studies an arbitrary year has been adopted, starting with September and running through to September of the succeeding year, instead of using the calendar or fiscal year. Insect outbreaks are undoubtedly predetermined to some extent by the conditions prevailing during the late fall and early winter of the year preceding the actual outbreak and culminate before the end of the calendar year in which the outbreak occurs. The fiscal year ending June 30 is obviously not adaptable to studies relating to insect activity.

In the discussion of insect outbreaks and associated meteorological conditions, it is often convenient to refer to a region rather than to a political unit. For convenience, we have adopted an arbitrary division of the United States into 12 regions. *New England* includes the States usually recognized under this name; the *Middle Atlantic States* include the Atlantic Coast States from New York to Virginia, inclusive, and also West Virginia and Pennsylvania; the *South Atlantic States* embrace the remainder of the Atlantic Coast States, including Florida. These three groups range from sea level to 1,500 feet in elevation, a few isolated mountain ranges running above this elevation, and a large part of the territory is in the Coastal and Piedmont regions.

The *North-Central States* include the two Dakotas, Minnesota, and Wisconsin, the entire region ranging from 500 to 1,500 feet elevation; the *East-Central region* takes in the States in the Ohio River Valley, including Illinois, Indiana, Ohio, Kentucky, and also Michigan; the *West-Central States* include the corresponding territory west of the Mississippi River—Iowa, Missouri, Nebraska, and Kansas; the *lower Mississippi Valley* includes all of the States bordering on the Gulf of Mexico, with the exception of Florida, and also includes Oklahoma, Arkansas, and Tennessee. The Central and Mississippi Valley States are all practically below the 3,000-foot elevation line. The lower Mississippi Valley States and South Atlantic States cover practically the cotton belt.

The *Rocky Mountain States* are Montana, Wyoming, and Colorado. With the exception of a small territory in northeastern Montana, these States are all above the 3,000-foot elevation line. The

Great Basin States are Idaho, Nevada, and Utah, also practically all above the 3,000-foot elevation line. The *Southwestern States* are Arizona and New Mexico. The remaining three States are called the *Pacific Coast States.*

In the temperature and precipitation studies being made by the survey, departures from the normal instead of means are being used. Acute outbreaks undoubtedly are reflections of abnormal meteorological conditions (plus or minus departures) associated with other limiting factors, otherwise they would be chronic conditions and not acute outbreaks.

As data accumulate, the regions over which certain pests are chronic will define themselves, and the normal meteorological range for these regions will be the range of optimum effectives for the given pest. Then a study of the means in other regions should be an index to the possibility of acute outbreaks in these regions. On the other hand, pronounced departures from the normal over the region of optimum effectives for a given pest should be reflected by an abnormal reduction in the abundance of that pest.

During the entomological season of 1921, starting in September, 1920, the weather over the entire region east of the Rocky Mountain and Southwestern States was marked by much wider departures from the normal in both rainfall and temperature than over the Western States. The weather in New England and in the Middle Atlantic and South Atlantic States was characterized by a slight excess of temperature and a more pronounced excess of precipitation in September, 1920, especially in the northern portion. In October the temperature excess increased, while generally over the region there was a very marked deficiency in rainfall. November was generally deficient in temperature, except in the Middle Atlantic States, while the rainfall was excessive. December, January, February, and March were warm throughout the entire region, the excess increasing as the winter advanced. Very serious freezes occurred March 28 and 29 over the lower Middle Atlantic and northern South Atlantic States. The rainfall in December was excessive, except in central and western Virginia, while during the remainder of the winter it was below normal. April was generally warm, with about normal rainfall; two severe killing frosts, however, did further serious damage during this month throughout the Middle Atlantic and South Atlantic States. During May, in New England and the northern Middle Atlantic States, temperature was about normal. In the South Atlantic States the temperature was low and the rainfall excessive. The remainder of the summer was above normal in temperature with the exception of August, which was a little deficient. The rainfall during the summer was very seriously below normal, being relieved in the New England and South Atlantic States in July,

but the drought continued throughout the summer in the Middle Atlantic States.

The conditions throughout the Central and Mississippi Valley States were somewhat similar to those along the Atlantic coast. Here September, 1920, was a little above normal, excess temperatures increasing in October and the moisture falling below normal in the North-Central and East-Central States. November's temperature was slightly below normal throughout the entire region, with the moisture decidedly below normal in the East-Central States. December, 1920, and January and February, 1921, were characterized by increasing excess departures in temperature, running well over 5° and reaching 10° in February in the North-Central and in March in the East-Central States. The rainfall in December, January, and February was generally about normal, with the exception of excessive rainfall in December in the lower Mississippi Valley. March was characteristically a wet month throughout the entire region. April was generally warm, except in the Gulf States, as was also May. Serious frosts occurred over the East-Central and West-Central States in the latter part of March and first part of April, however, destroying much of the fruit. The rainfall was above normal in the North-Central States in April, while in the East-Central, West-Central, and lower Mississippi Valley May was very dry. June, July, and August were above normal in temperature throughout the entire Central and Mississippi Valley regions, the moisture being below normal in June in the North-Central and East-Central States, about normal in the West-Central States, and above normal in the lower Mississippi Valley. In July the rainfall was below and in August above normal in the North-Central and East-Central States, while the lower Mississippi Valley was experiencing a drought. September, 1921, throughout this entire territory was above normal in both temperature and rainfall, with the exception of a deficiency of rainfall in the lower Mississippi Valley.

The regions in and west of the Rocky Mountains also had generally mild winter, with but few marked departures from the normal. The Pacific coast had excessive precipitation in December, 1920, while the Southwest had a similar excess in June, July, and August following a dry winter and spring. September, 1921, was dry throughout this entire territory with the exception of the Pacific Coast States and the temperature was normal or slightly below.

The generally mild winter of 1920 and comparatively warm spring of 1921 seemed to have been particularly favorable for the development of lepidopterous insects. The corn earworm, European corn borer, cankerworms, webworms, cutworms, alfalfa caterpillars, and many other species were abnormally abundant in various parts of the country. The cotton worm made one of its periodic northern

sojourns, appearing in September in Louisiana and Texas and in October as far north as Michigan and New York State.

The clover-leaf weevils were very troublesome in the East-Central and West-Central States and were also reported from the northern Pacific coast.

The plum curculio was quite troublesome in the New England, Middle Atlantic, and East-Central States.

Blister beetles were extremely abundant throughout the entire country east of the Rocky Mountains, reports of serious depredations having been received from New York, Indiana, Illinois, Ohio, Missouri, Mississippi, South Dakota, and Nebraska. Dr. Arthur Gibson, Dominion entomologist of Canada, says:

> These insects appeared in numbers in the various Provinces as follows: In New Brunswick and other sections of eastern Canada the ash-gray blister beetle, *Macrobasis unicolor* Kby., caused important injury to the foliage of potatoes. In the prairie Provinces the western blister beetle, *Cantharis nuttalli* Say, occurred in numbers on beans and certain other crops. *Epicauta puncticollis* Mann. was reported from Alberta, where it was found attacking potatoes and beans. In Manitoba, *Macrobasis murina* Lec. was found in numbers on the foliage of the same plants.

The pea aphis was reported as very destructive in Oklahoma, Kansas, Missouri, and Illinois very early in the season, while during May and June reports of serious depredations by this pest were received from Oregon, Colorado, and Nebraska.

With the extremely fragmentary data on ecological conditions throughout the country at present available, it is obviously necessary to limit the annual summary to the few insects that are attracting the particular attention of the working entomologists in the several States. Therefore, in the following pages the entomological situation for the season of 1921 has been reviewed as it relates to 19 of the more serious and conspicuous insect pests of this country.

CORN EARWORM.

(*Heliothis obsoleta* Fab.)

During the past season the corn earworm has been one of the most serious and important pests. It has been of unusual abundance over much of its range, and has extended its depredations far to the north of its usual limits.

In New England the pest was reported from Maine for the first time since 1915, and the second time since 1892. Doctor Patch reported rather serious infestations over the southern half of the State, covering much of the important sweet-corn canning region. In Massachusetts the only previous records of the occurrence of this insect since 1886, when the State experiment station was organized, are from the extreme southern border of the State. This year the

pest swarmed over the entire State and in many cases as high as 95 per cent of the ears of sweet corn were infested. The pest was also reported as much more numerous and destructive than usual in Connecticut, and a single report was received from Newfane in the southern part of Vermont.

In the Middle Atlantic States the outbreak was unusually severe. Pennsylvania reported the insect as abnormally destructive over the entire corn-growing area. A similar report was received from New Jersey, where an actual count showed sweet corn damaged to the extent of 30 per cent and field corn 15 per cent. In New York the infestation ran into the extreme northeastern corner on the Canadian boundary. In Delaware the demonstration plats at the experiment station showed from 10 to 15 per cent loss, and the pathologist of the experiment station reported that usually *Fusarium moniliforme* Shel., *Cephalosporum sacchari* Butler, and *Diplodia zeae* Lev. are associated with corn earworm damage. Virginia and West Virginia reported the infestation general, Virginia estimating that from 3 to 5 per cent of the corn was lost because of the ravages of this insect, while West Virginia recorded 90 to 95 per cent of the ears infested by actual count.

In North Carolina the pest was generally distributed, but not reported as unusually abundant. In South Carolina the infestation was most serious along the coastal region, extending from Aiken to Horry Counties and southeastward to the coast, the center of the infestation being in Barnwell County. In Florida the pest was particularly abundant and destructive. By actual count the crop was found to be damaged in some places from 10 to 25 per cent, while in the region about Sandford fields were completely destroyed.

In the North-Central States the infestation was unusually severe. This pest, though usually present, rarely attracts any considerable attention. In Michigan the entire lower peninsula was generally infested, the infestation ranging from 10 to 75 per cent of the ears. The southern half of Minnesota, north to a line extending from Clay to Chisago Counties, was infested. On the experimental plats at the station an actual count showed that from 20 to 30 per cent of the ears were infested. In Wisconsin the southeastern counties were quite generally infested north to Adams County, and west to and including Dane County. In North Dakota the insect was unusually abundant in the southeastern part, and in South Dakota it was serious in the eastern tier of counties, and also in the central and west-central counties.

Arthur Gibson, Dominion entomologist, reports that by far the worst infestation of which they have any record occurred in Canada in 1921. In Ontario late sweet corn was injured in some fields to the extent of 25 per cent of the crop. In certain districts the ears were

infested to such an extent that they were refused by canning companies. The pest was also very serious in the Provinces of Quebec, Manitoba, and British Columbia.

In the East-Central States the damage was of record importance. In Ohio the outbreak was worse than any since 1904, and probably the most severe ever recorded. Field corn was reduced from 5 to 10 per cent of its actual bulk, and in the canning section sweet corn was damaged to about 50 per cent. In Indiana the outbreak was the worst in the past 10 years, the infestation estimated as ranging from 5 to 30 per cent. In this State the ear rots were also reported as accompanying the earworm injury. In Illinois the outbreak was unusual; 75 per cent of the sweet corn was reported as infested and 5 per cent of the grain crop destroyed. Here and in Indiana the outbreak was most conspicuous in the northern half of the State. In Kentucky the outbreak was the most severe ever observed by Professor Garman.

In Iowa the outbreak was the most serious in the experience of the reporter, which covered six years. In Nebraska the infestation was quite general, being worst in the east and east-central parts of the State. The most serious corn earworm outbreak ever recorded in Missouri occurred during the past year, the infestation being practically 100 per cent throughout the State. In Kansas the outbreak was not unusual, destruction of the corn ranging from 3 to 5 per cent. In the western part of the lower Mississippi Valley a similar condition prevailed to that in Kansas, the outbreak being about normal.

In the eastern part of the lower Mississippi Valley the outbreaks ranged from normal to slightly above normal. In Louisiana tomatoes in the experiment station plats were damaged from 30 to 35 per cent. In Alabama the pest was recorded as unusually abundant, while in Arkansas it was not more destructive than during average years.

In the Rocky Mountain region no damage was experienced, except in the eastern part of Colorado, east of a line extending from Larimer to Huerfano Counties, where the pest is usually quite destructive.

In the Great Basin no outbreaks were reported.

In the Pacific coast region, Oregon reported the insect as fairly abundant in the Willamette Valley, where it has been one of the major corn pests since 1898. A remarkable feature of this insect's habits in Oregon is that it is never recorded as attacking tomatoes, beans, or, in fact, any plants except corn. In California this insect was recorded for the first time as attacking cotton, reports having been received from Glenn and Kern Counties during 1921; the outbreaks, however, were not serious. In the canning sections of central and southern California the pest was very serious and

caused considerable loss. In the coast region about San Francisco Bay the corn earworm has become so serious a pest that the growing of sweet corn has been discontinued.

One of the striking features of this year's corn earworm outbreak was the rather unusual damage occasioned to alfalfa, reports of serious damage to this crop having been received from Illinois, Kansas, and Kentucky. Injury to vetch was reported from Alabama. Another unusual feature was the serious damage done to greenhouse crops in Indiana; roses, chrysanthemums, carnations, and geraniums suffered severely from the feeding of these larvæ on the flower buds and stems, the damage ranging from 10 to 90 per cent of the crop.

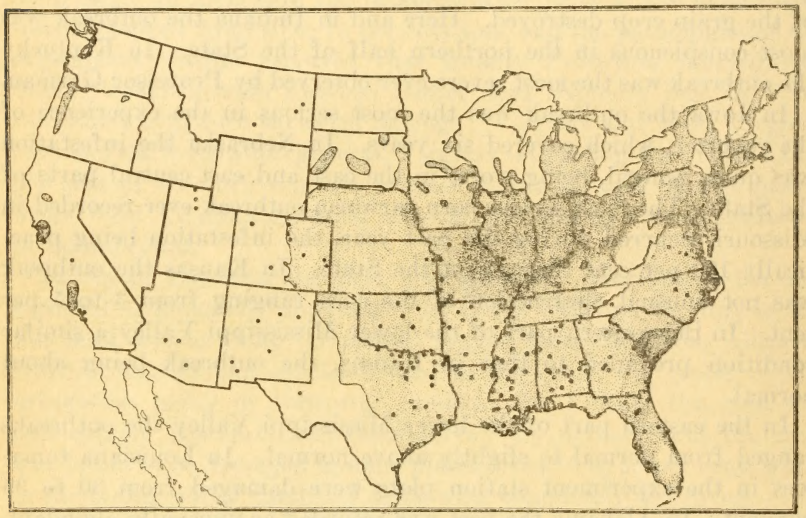

FIG. 1.—Geographical distribution of the corn earworm in the United States: Heavily shaded area, very seriously infested in 1921; lighter shading, area of appreciable damage in 1921; black dots, localities where serious outbreaks have occurred previous to 1921.

Table 1 gives some impression of the seriousness of this pest during the past season. The figures on the bushels of field corn produced in 1921 were provided by the Bureau of Markets and Crop Estimates. The percentages of damage were obtained from actual counts by the entomological collaborators of the survey, or were estimated from the percentage infestation obtained by actual count. No attempt has been made to reduce this loss to dollars and cents, but the damage to corn ran well over 175,000,000 bushels.

The figures on sweet corn are very fragmentary, but in the four States sending in estimates the damage amounted to over $1,500,000.

The accompanying map (Fig. 1) indicates the localities from which this insect has been reported, both in the past and during the season of 1921, the heavily shaded area indicating the region of

unusual abundance in 1921, the lighter shading indicating appreciable damage in 1921, and the black dots, localities of serious infestation in previous years drawn from literature.

TABLE 1.—*Estimated damage to field corn by the corn earworm.*

State.	Bushels in crop, 1921.	Percentage infested in 1921.	Percentage damaged in 1921.	Estimated bushels damaged, 1921.
Illinois	306,000,000	.....	5	15,300,000
Indiana	169,800,000	.....	[1] 7	11,886,000
Ohio	159,300,000	.....	7	11,151,000
Missouri	182,900,000	100	[1] 10	18,290,000
Minnesota	140,500,000	20–30	[1] 1	1,405,000
Kansas	102,100,000	.....	4	4,084,000
Michigan	66,400,000	10–75	[1] 1	664,000
Virginia	47,600,000	.....	4	1,904,000
West Virginia	20,100,000	90–95	[1] 4	804,000
New York	36,700,000	30–40	[1] 2	734,000
New Jersey	11,300,000	.....	[1] 15	1,695,000
Massachusetts	3,100,000	5–95	[1] 2	62,000
Total for above 12 States	1,245,800,000	.....	.....	67,979,000
United States	3,080,400,000	.....	.....	175,612,000

[1] Estimated.

HESSIAN FLY.

(*Phytophaga destructor* Say.)[1]

The Hessian fly outbreak which threatened during the summer and fall of 1920 has declined to a point that warrants the assumption that but little damage will be done by this pest during the summer of 1922. The fly was of minor importance in comparison with the great outbreak of 1915 and 1916.

In the territory east of the Appalachian Mountains the spring brood was very serious in North Carolina, South Carolina, and tidewater sections of eastern Maryland. In North Carolina the damage was confined to the west-central part of the State, while the outbreak in South Carolina was contiguous with that in North Carolina. In the latter State the crop failure was complete in places. The fall brood was generally very light over this region, with the exception of a few localized infestations in New York and tidewater Maryland. In New York the average infestation in the 14 principal wheat-growing counties amounted to 7.33 per cent.

Among the East-Central States, Ohio reported that a midsummer survey, carried on in 31 counties, showed an average of 17 per cent infestation as against 44 per cent infestation in 1920. In nine northwestern counties the infestation ran as high as 35 per cent. In these counties, however, parasitism was very high, averaging from 50 to 60 per cent.

[1] From reports of W. R. Walton, Bureau of Entomology, and survey collaborators in the several States.

In Indiana a large spring brood was reported early in April, 99 per cent of the stalks being infested in places in the southern part of the State. During June much fallen wheat was observed. In Illinois the infestation was slight except in a few of the west-central counties along the Mississippi River. Iowa reported that the Hessian fly was on the increase in the southeastern and south-central counties, the winter wheat examined on December 22 being very badly infested.

Minnesota reported practically no flies, while Wisconsin reported no serious infestation, but flies present over the southern tier of counties.

According to W. H. Larrimer, Bureau of Entomology, the general infestation throughout the Central States, although showing some irregularities, has declined greatly, due no doubt to the response of wheat growers to the efforts of extension and other entomologists of Ohio, Indiana, Illinois, and Missouri in cooperation with the Federal Bureau of Entomology. The recommended safe-sowing dates held remarkably well in the fall of 1921 and there seems to be no doubt that if wheat growers had not adopted the recommendations a heavy infestation would have occurred in practically all early sown wheat. There was no indication of a late wave of the Hessian fly such as existed during the fall of 1920. A slight supplemental brood, originating in volunteer wheat, was present in local areas from La Fayette, Ind., southward, but in general the status of the fly during the fall of 1921 was considerably less menacing than was the case early in the spring. Practically all wheat sown before these dates began the winter in splendid condition, and practically no Hessian fly infestation occurred in this grain. A slight menace to this grain exists in some regions in the volunteer wheat. Parasitism is rapidly increasing.

In the area west of the Mississippi River, according to J. R. Horton, Bureau of Entomology, no serious infestations occur at the present time, except in northeastern Oklahoma, where local heavy infestations are indicated. Conditions in Kansas are especially promising so far as the Hessian fly is concerned. The heaviest infestation in the fall examinations was in Sedgwick County, which showed an infestation of between 3 and 4 per cent. The prospects for a crop, however, are not as favorable as might be expected, owing to adverse meteorological conditions.

Missouri reported early in the season the worst outbreaks since 1916, Doctor Haseman stating that counts made in July in 29 counties averaged 21 per cent of the straws infested, the heaviest infestation being in the 14 central counties, where the infestation ran as high as 36 per cent, while the infestation in the western counties dropped to 11 per cent. The winter wheat was not sown

until after the fly-free date in the northern part of the State north of the Missouri River. This was partly due to the efforts of the Hessian fly campaign and was also due, in part, to the heavy rains which delayed plantings in many localities. South of the Missouri River the rains abated early enough to induce a great deal of planting from one to three weeks before the fly-free date, and very heavy infestation of the Hessian fly was reported about the middle of October in this region. North of the river the volunteer grain was also badly infested.

In Nebraska the Hessian fly was present in rather menacing numbers early in the spring. By midsummer a rather serious spring

FIG. 2.—Geographical distribution of serious chinch-bug infestations in the United States in 1921: Solid-colored area, very seriously infested; shaded area, general infestation; lines limit western and southern known distribution; dots are records from literature.

brood was present all over the eastern counties. The September examinations, however, showed that the fly was only present in serious numbers in a few scattering localities.

On the Pacific coast the fly was reported as less serious than in 1920, but much lodging of wheat occurred in the Willamette Valley due to unusual winds where slight fly infestation occurred.

CHINCH BUG.

(*Blissus leucopterus* Say.)

The chinch bug appeared as a serious pest during the season of 1921 over only a small part of its normal range of destructive abundance. The area seriously infested extended in a southwesterly-

northeasterly direction, from the north-central part of Texas, across the center of Oklahoma, eastern Kansas, most of Missouri, southern Illinois, central Indiana, into the northwestern corner of Ohio and the southern tier of counties in Michigan.

The very seriously infested area (Fig. 2) was confined almost exclusively to Indiana, Illinois, and Missouri. In Indiana the pest has been steadily on the increase in destructive abundance since 1917. In 1917 very few chinch-bug cases were reported to the station; reports in numbers started to come in during the season of 1918, were almost

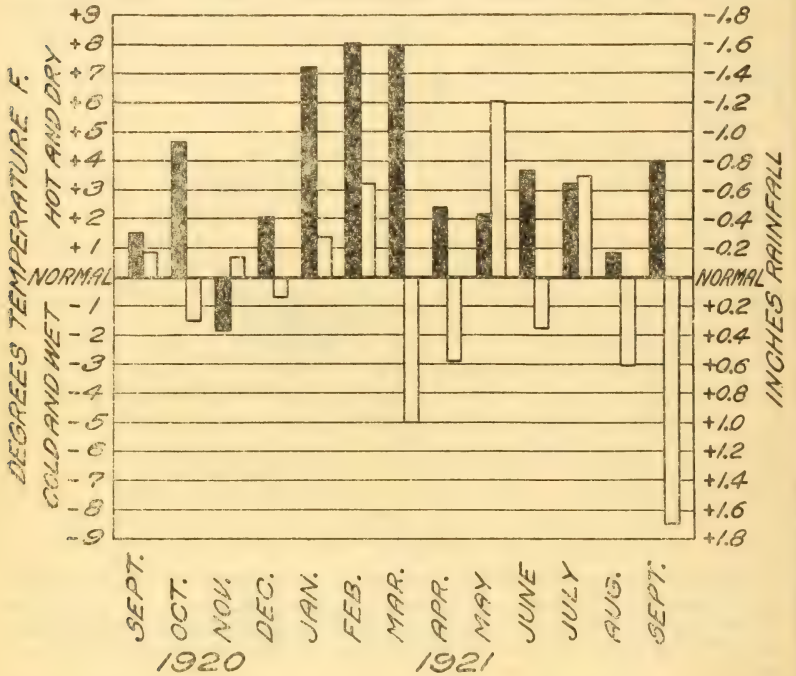

FIG. 3.—Monthly departures from normal temperature (solid black) and rainfall (white) for the fall of 1920, the winter of 1920–21, and the growing season of 1921 in the region infested by the chinch bug during 1921. (See also Table 2.)

doubled during 1919, and quadrupled in 1920. During 1921, 52 counties were infested. The northern limit of the infested area in Indiana extended from the north-central part of Steuben County almost directly southwestward to the southern border of Warren County, while the southern limit extended from the center of Union County, through the southeastern corner of Morgan County, to the southeastern corner of Posey County. The area of severe infestation ran parallel to these two lines, running on the north from the center of DeKalb County to the southern part of Vermillion County, and on

the south from the center of Wayne County through the northwestern corner of Johnson County to the northwestern corner of Gibson County.

In Illinois the infested area was continuous on the east with that of Indiana, the northern boundary extending across the State from the southern third of Iroquois County to the northern third of Hancock County, and on the south to the southern border of the State. The seriously infested area extended from the southeastern corner of Edgar County, through the southern third of Piatt County and the center of Cass County, to the center of Adams County, southward to the southern borders of Galla, Hamilton, Franklin, and Jackson Counties. During the early fall the number of bugs was materially decreased by heavy rains, but the last observation indicated that there were enough of these insects in hibernation to cause serious damage during the coming growing season over a large part of the southern half of Illinois.

In Missouri the infested area covered the greater part of the State. The only regions from which no reports of infestation were received were Pemiscot County in the southeastern corner, a small area including Tanney and Ozark Counties on the southern border and extending northward to Laclede County, and a few counties along the northern border. The most seriously infested area was continuous with that in Illinois, narrowing in a northwesterly direction.

A small area in Kansas covering the greater part of Atchison and Jefferson Counties was most seriously infested, while a generally moderate infestation covered the eastern third of the State. The infestation in Oklahoma was not unusual and covered an area extending diagonally across the State, on the north from Woods County to the southern third of Ellis County and south from Delaware County to the southwestern corner of Bryan County. This outbreak, though not severe this season, indicated a decided increase of this pest.

In Nebraska there was an infestation in the southern half of Thayer and Jefferson Counties. A rather unusual outbreak occurred late in the season in the northeastern part of the State in Knox County, the bugs first appearing in barley and later moving to the corn, where they did a considerable amount of damage.

In Ohio there were apparently more chinch bugs than there have been since the seasons of 1904, 1905, and 1906, extending over practically all of the western part of the State, the most serious area being confined to Defiance, Pauling, and Williams Counties, in the northwestern corner.

In Iowa this insect appeared for the first time in 20 years in the south-central part in Decatur County.

The northern limit of the outbreak was the southern tier of counties in Michigan, including the greater part of Lenawee and Hillsdale Counties, and the southern part of Branch, St. Joseph, and Monroe Counties. As far as the records of the station go, this outbreak is the first that has occurred in Michigan since 1887.

An isolated outbreak of minor importance appeared in South Dakota in the southeastern part covering Bon Homme and Charles Mix Counties. This was the first outbreak during at least the past 12 years.

In Texas the only report of serious damage was received from Hill County. The pest occurred in normal numbers, however, over the region usually infested.

The temperature over the whole infested territory was above normal during the early fall of 1920. November, however, had an average deficiency of 1.8°, the deficiency being greatest in Missouri, Kansas, and Oklahoma where it was between 3° and 5°. The winter of 1920–21 was unusually warm, the average departures during January, February, and March being over 7° F. The spring and summer were also warmer than usual. (See Fig. 3 and Table 2.)

The rainfall over this region was about normal during the fall and winter, being generally below normal during the winter months. In March wet weather set in, the average being over an inch above normal during this month. April was also above normal, while May was quite dry throughout the entire region, the deficiency being 1¼ inches. June and July were dry throughout most of the region, although there were heavy rains in June in Oklahoma and Texas, where the excess was between 3 and 4 inches, bringing the average for the region above the normal. August and September were generally wet, September having an excess of precipitation of 1.69 inches. The dry periods in May and July were advantageous to the development of young chinch bugs while the wet weather of August and September undoubtedly did much to reduce the infestations of the fall brood over much of the infested region.

The accompanying map (Fig. 2) indicates the areas generally infested in 1921 (shaded), the area of most serious damage in 1921 (black), and the line limiting the western known distribution of the pest. The black dots are isolated reports, from literature, beyond this western limit of distribution.

TABLE 2.—*Monthly departures from normal temperature and rainfall for the fall of 1920, the winter of 1920–21, and the growing season of 1921 in the region infested by the chinch bug during 1921.*

DEPARTURES (IN DEGREES FAHRENHEIT) FROM NORMAL TEMPERATURE.

State.	1920				1921								
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Michigan	+2.4	+7.3	−0.5	+4.3	+6.1	+7.5	+6.9	+6.3	+3.6	+6.1	+7.0	+0.7	+5.0
South Dakota	+2.2	+5.9	−.5	+1.4	+10.5	+12.4	+6.5	+2.4	+1.4	+6.9	+3.8	+.9	+1.0
Iowa	+3.1	+6.9	+.4	+2.5	+10.5	+10.5	+9.5	+3.7	+2.8	+5.6	+3.8	+.3	+3.9
Nebraska	+1.4	+4.2	−1.4	+1.2	+8.4	+9.1	+7.3	+4.0	+1.6	+3.8	+1.8	+1.1	+2.7
Missouri	+1.4	+4.3	−3.5	+2.6	+7.2	+9.1	+8.5	+.9	+2.0	+3.4	+2.9	+.8	+4.7
Kansas	+.6	+3.8	−4.4	+3.2	+6.9	+9.0	+7.3	+.9	+2.4	+1.6	+1.1	+1.4	+4.6
Ohio	+.8	+5.3	−.8	+2.9	+4.7	+6.4	+10.1	+5.3	+1.3	+4.2	+4.2	−1.1	+4.6
Indiana	+1.6	+5.9	−.8	+1.3	+5.6	+7.0	+10.1	+3.9	+2.1	+4.7	+5.1	−.5	+4.7
Illinois	+2.6	+5.7	−1.3	+2.8	+7.8	+8.7	+9.9	+3.9	+2.9	+5.2	+4.8	+.1	+4.6
Oklahoma	+.4	+2.1	−4.2	+2.0	+5.7	+6.1	+4.7	−.7	+2.5	+.6	+.4	+2.1	+5.0
Texas	+1.8	+.5	−2.3	+.5	+5.7	+3.6	+5.6	−1.8	+.6	−.8	+.0	+1.7	+4.0
Regional mean	+1.6	+4.7	−1.8	+2.2	+7.2	+8.1	+7.8	+2.3	+2.1	+3.6	+3.2	+.7	+4.0

DEPARTURES (IN INCHES) FROM NORMAL RAINFALL.

Michigan	−0.57	−0.84	−0.24	+1.25	−1.18	−0.77	+1.61	+1.15	−1.48	−0.92	−0.62	+1.29	+0.73
South Dakota	−.39	−.48	+.56	+.02	−.20	−.41	+.21	−.34	+.02	−1.59	+.76	+.52	+2.07
Iowa	−.06	−.33	+.68	−.06	−.54	−.38	−.20	+.48	−.34	−.62	−1.43	+1.36	+3.36
Nebraska	−.93	+.60	+.42	+.04	+.18	−.30	−.45	−.53	+.01	−1.44	+.67	−.29	+.19
Missouri	+.92	+.25	−1.09	−.22	−.38	−1.33	+1.68	+1.52	−1.20	+1.15	−1.77	+1.63	+3.15
Kansas	+.22	+1.04	+.19	−.07	+.37	−1.01	+.06	+.72	−1.31	+.81	−.37	+.26	+.58
Ohio	−.16	−.59	+.30	−.57	−.69	−.58	+2.47	+.67	−.43	−.93	−1.03	+.71	+1.67
Indiana	−.18	−.33	−1.04	+.53	−.74	−.92	+2.01	+.81	−1.81	−.33	−1.27	+2.09	+2.58
Illinois	−.87	−.32	−1.44	+.65	−.93	−1.26	+2.10	+1.39	−2.11	−.08	−1.57	+1.81	+3.10
Oklahoma	+.65	+2.92	−.29	+.47	+.84	+.13	+1.05	+.18	−2.84	+4.24	−.60	−1.11	+.01
Texas	−.65	+1.20	+.27	−.66	+.04	−.29	+.82	+.46	−1.74	+3.39	−.42	−1.60	+1.20
Regional mean	−.18	+.28	−.15	+.12	−.29	−.64	+1.03	+.59	−1.20	+.33	−.69	+1.02	+1.69

GREEN BUG.

(*Toxoptera graminum* Rond.)[2]

The green bug was of comparatively little importance during the season of 1921. Early in the season the pest appeared in rather threatening numbers in parts of Texas, Oklahoma, and Kansas, but dry weather later in the season reduced the injury to a negligible factor. The areas from which reports of infestation were received include a narrow strip of territory extending from Bell and Coryell Counties in Texas northward through Ellis, Denton, Collin, and Grayson Counties, into Bryan County, Okla. Oats were seriously injured in some of the northern counties of Texas where the loss was estimated at about 25 per cent. Quite serious infestations were also recorded from north-central Oklahoma, including Oklahoma, Logan, Noble, and Tulsa Counties. (Fig. 4.)

In Kansas the infestation was confined to the southeastern tier of counties, being most severe in Cherokee County and diminishing westward to Cowley County. Sumner County was practically free of the green bug.

[2] Drawn largely from the reports of J. R. Horton, S. J. Hunter, R. H. Beamer, J. W. McColloch, C. E. Sanborn, and E. E. Scholl.

A few isolated green-bug outbreaks were reported from Missouri, one in Jasper County, continuous with that in Cherokee County, Kans., and two isolated outbreaks in the southeastern part, in Perry and Mississippi Counties.

In the three States infested by the green bug during 1921 the weather was very uniform, there having been a period of cold weather in November, 1920. (See Table 3 and Fig. 5.) This was followed by a very mild winter, January, February, and March running to 6° F. above normal while February in Kansas was 9° F. above normal. The spring started out with decided excess tempera-

FIG. 4.—Geographical distribution of the green bug in the United States in 1921: Heavy shading indicates serious damage; light shading, threatened damage.

ture in March. This was followed by a rapid drop in April which carried it below the normal in both Oklahoma and Texas. The spring and early summer were very nearly normal, the temperature rising during August and September to slightly above normal.

The rainfall throughout this region was above normal throughout most of the winter with the exception of the month of February. (See Table 3 and Fig. 6.) The spring was about normal up to May when a very decided drought set in. This was followed, however, in June by an excess of rainfall in Oklahoma and Texas of over 3 inches. August and September in these last two States were very dry while Kansas was about normal.

Figure 4 indicates the area of threatening outbreaks in the spring of 1921 (shaded lightly) and the area where damage was recorded (heavy shading).

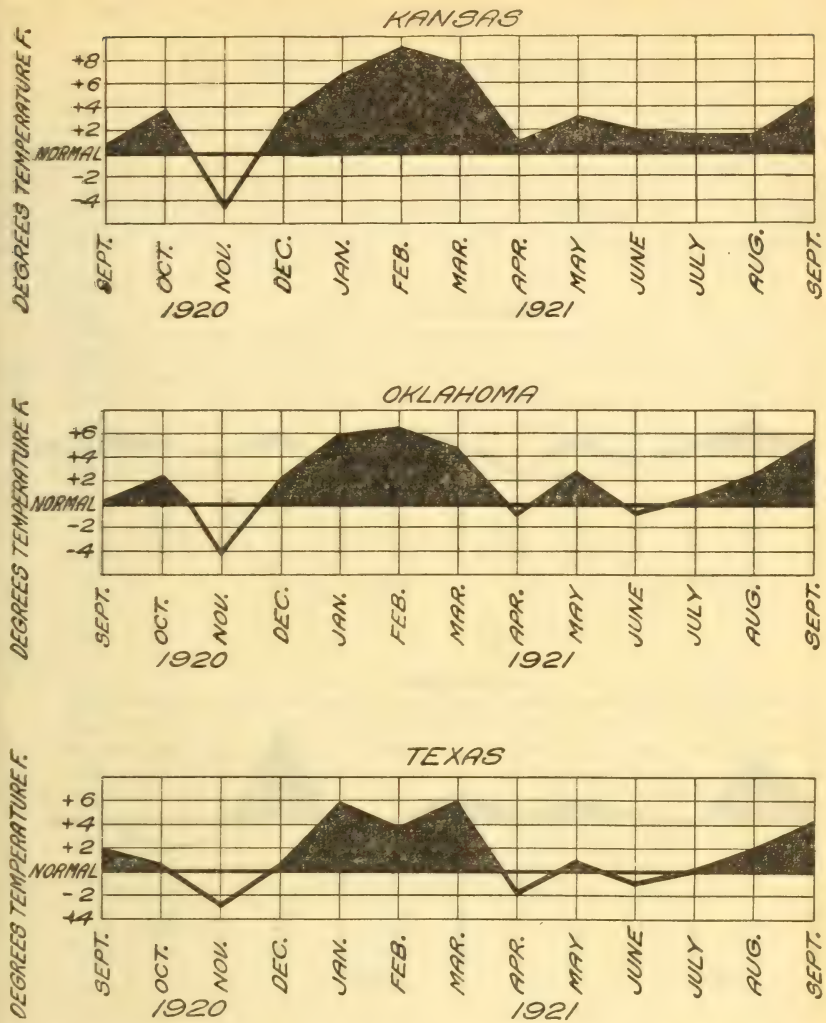

FIG. 5.—Monthly departures from normal temperature for the fall of 1920, the winter of 1920–21, and the growing season of 1921 in the region infested by the green bug in 1921. (See also Table 3.)

TABLE 3.—*Monthly departures from normal temperature and rainfall for the fall of 1920, the winter of 1920–21, and the growing season of 1921 in the region infested by the green bug in 1921.*

DEPARTURES (IN DEGREES FAHRENHEIT) FROM NORMAL TEMPERATURE.

	1920.				1921.								
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Kansas	+0.6	+3.8	−4.4	+3.2	+6.9	+9.0	+7.3	+0.9	+2.4	+1.6	+1.1	+1.4	+4.6
Oklahoma	+ .4	+2.1	−4.2	+2.0	+5.7	+6.1	+4.7	− .7	+2.5	− .6	+ .4	+2.1	+5.0
Texas	+1.8	+ .5	−2.9	+ .5	+5.7	+3.6	+5.6	−1.8	+ .6	− .8	+ .0	+1.7	+4.0
Regional mean	+ .9	+2.1	−3.8	+1.9	+6.1	+6.2	+5.8	− .5	+1.8	+ .0	+ .5	+1.7	+4.5

TABLE 3.—*Monthly departures from normal temperature and rainfall for the fall of 1920, etc.*—Continued.

DEPARTURES (IN INCHES) FROM NORMAL RAINFALL.

	1920				1921								
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Kansas	+0.22	+1.4	+0.19	−0.07	+0.37	−1.01	+0.06	+0.72	−1.31	+0.81	−0.37	+0.26	+0.58
Oklahoma	+ .65	+2.92	− .29	+ .47	+ .84	+ .13	+1.05	+ .18	−2.84	+4.24	− .60	−1.11	+ .01
Texas	− .65	+1.20	+ .27	− .66	+ .04	− .29	+ .82	+ .46	−1.74	+3.39	− .42	−1.60	+1.20
Regional mean	+ .07	+1.72	+ .05	− .09	+ .41	− .39	+ .64	+ .45	−1.96	+2.81	− .46	− .81	+ .59

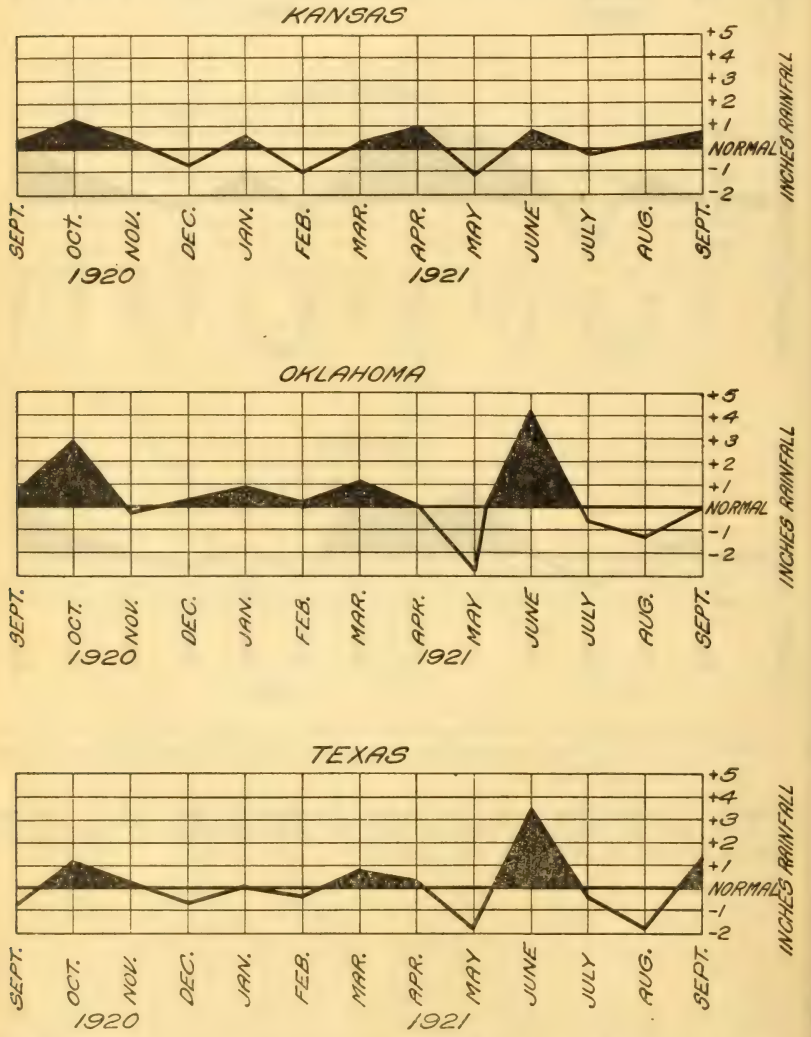

FIG. 6.—Monthly departures from normal rainfall for the fall of 1920, the winter of 1920–21, and the growing season of 1921 in the region infested by the green bug in 1921. (See also Table 3.)

PALE WESTERN CUTWORM.

(*Porosagrotis orthogonia* Morr.)

During the season of 1921 the pale western cutworm was again seriously abundant in parts of the Rocky Mountains and North-Central States, the most serious damage being reported from Montana. Rather extensive outbreaks occurred in southwestern North Dakota, and the pest was generally destructive over the winter-wheat sections of eastern Colorado.

Arthur Gibson, Dominion entomologist, reports:

Of the cutworms the chief species reported was the pale western cutworm which devastated large areas of wheat land in southern Alberta and also caused some damage in certain sections of southern Saskatchewan.

FIG. 7.—Geographical distribution of the pale western cutworm in the United States in 1921; Coarsely shaded area, very seriously infested; finely shaded area, generally infested; black dots, records from literature.

In Montana the area of general distribution extended over the greater part of the State from the eastern border westward to the center of Glacier National Park, and Jefferson County. During 1921 the pest destroyed from 33 to 35 per cent of the seeded area in Glacier National Park and in Toole, Liberty, Hill, and Cascade Counties, and damaged from 6 to 15 per cent of the seeded area in Dawson, Prairie, and Fallon Counties in the east-central part of the State and Broad Water and Jefferson Counties in the southwestern part. The outbreak as a whole, however, seemed less serious than the outbreak of 1920.

In North Dakota the outbreak was confined to the area south of Golden Valley and Oliver Counties and west of Morton and Grant

Counties. The larvae were so numerous that by actual count as many as 17 were found to a square foot in some wheat fields, while the average over the entire infested region was about five cutworms in this same area. They were also very destructive to young corn.

In Colorado this insect was somewhat more active than usual, particularly in the winter-wheat area east of a line extending from Jackson County to Graham County, in the northeastern part, and Crowley and Las Animas Counties in the southeastern part.

This pest has been recorded in literature from Wyoming, Utah, Nevada, California, Arizona, and New Mexico, in addition to the States infested in 1921.

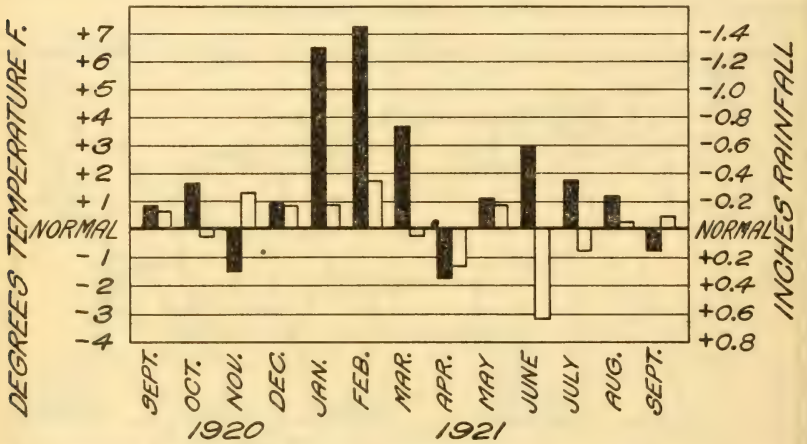

FIG. 8.—Monthly departures from normal temperature (solid black) and rainfall (white) from September, 1920, to September, 1921, inclusive, in the region infested by the pale western cutworm. (See also Table 4.)

In the region infested by this pest the temperatures were quite normal during the fall of 1920. During the winter of 1921 very mild weather prevailed, January and February averaging over 6° F. excess temperature. May was below normal, while the remainder of the spring and summer showed substantial excesses up to September, which showed a temperature deficiency of 2.9° F. (See Table 4 and Fig. 8.)

The rainfall over this region was generally below normal during the fall of 1920 and winter of 1920–21. Only slight excesses of precipitation occurred in April and June. (See Table 4 and Fig. 8.)

The map (Fig. 7) illustrates the area generally infested in 1921 (fine shading), the areas very seriously infested in 1921 (coarse shading), and previous records of occurrence (black dots).

TABLE 4.—*Monthly departures from normal temperature and rainfall from September, 1920, to September, 1921, inclusive, in the region infested by the pale western cutworm.*

DEPARTURES (IN DEGREES FAHRENHEIT) FROM NORMAL TEMPERATURE.

	1920.				1921.								
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
North Dakota	+2.6	+5.6	+1.4	+2.2	+11.2	+11.9	+2.6	−0.6	+1.2	+5.5	+3.9	+1.8	+0.6
Montana	+ .9	+1.6	−1.3	+2.5	+ 7.5	+ 8.9	+2.7	−1.1	+ .3	+3.6	+1.5	+1.8	−3.9
Wyoming	− .1	− .5	−3.7	+1.4	+ 3.8	+ 5.1	+4.3	−2.6	+1.0	+3.3	+1.3	+ .8	− .7
Colorado	− .9	− .7	−2.4	−2.8	+ 3.7	+ 3.6	+4.9	−2.3	+1.5	+ .5	+ .5	− .1	+1.1
Regional mean	+ .6	+1.5	−1.5	+ .8	+ 6.5	+ 7.4	+3.6	−1.6	+1.0	+3.2	+1.8	+1.1	− .7

DEPARTURES (IN INCHES) FROM NORMAL RAINFALL.

North Dakota	0.58	−0.48	−0.21	−0.22	−0.32	−0.10	+0.17	+0.43	−0.09	+0.55	+0.43	−0.36	+1.66
Montana	− .55	+ .03	− .51	− .17	− .31	− .30	+ .41	+ .13	− .32	+ .01	+ .00	− .63	− .28
Wyoming	− .33	+ .28	− .10	− .08	− .04	− .48	− .34	− .19	+ .06	+ .36	− .18	− .27	− .77
Colorado	− .27	+ .32	− .09	− .24	+ .05	− .47	− .10	+ .72	− .39	+1.52	+ .36	+1.17	− .97
Regional mean	− .14	+ .03	− .22	− .17	− .15	− .33	+ .03	+ .27	− .16	+ .61	+ .15	− .02	− .09

ALFALFA WEEVIL.

(*Phytonomus posticus* Gyll.)[3]

Since its original discovery in this country in the spring of 1904, the alfalfa weevil has continued to spread over the alfalfa-growing sections of the Great Basin and Rocky Mountain States and into the northern Pacific Coast States.

The original infestation in Utah has now spread to cover the entire northern two-thirds of the State, from Beaver County on the southwest to Duchesne and Summit Counties on the northeast, thence northwestward over the State, and into Idaho and Wyoming.

In Idaho the infestation is now known to be present in 28 counties, all in the southern part. Counties in which the weevil was discovered for the first time are Twin Falls, Owyhee, Gooding, Custer, Camas, Butte, and Blaine. The weevil was found in Owyhee County in the extreme northwestern corner, where it occurs sparsely in the Gem irrigation district. Weevils were abundant enough in the Arco, Mackey, and Carey localities of Butte, Custer, and Blaine Counties to be doing considerable damage. The infestation in Camas County is light, increasing from Fairfield to the alfalfa fields farthest east in the county. A single weevil was found in Gooding County in the Hagerman Valley near the town of Hagerman. In Twin Falls County the weevil was found to be present from about 3 miles west of Murtaugh to the easternmost alfalfa fields in the county; the infestation was light, however, and but little injury is anticipated in the immediate future. In Clark County the infestation has spread over all alfalfa sections. In the southeastern counties of Idaho the

[3] Reported by G. I. Reeves, of the Bureau of Entomology, and Claude Wakeland, of the Idaho Extension Service.

alfalfa weevil caused little injury this season; although climatic conditions may explain part of this phenomenon, it is evident that the parasite *Bathyplectes curculionis* Thoms. has been an important factor.

In Payette County the beetles were so numerous as absolutely to prevent any growth of the second crop for from four to six weeks, and in many places they turned their attention to garden truck after completely defoliating the alfalfa.

In Wyoming the weevil has been found in the southern part of Lincoln County, at several points in Uinta County, and at two points in Sweetwater County in the southwestern corner of the State.

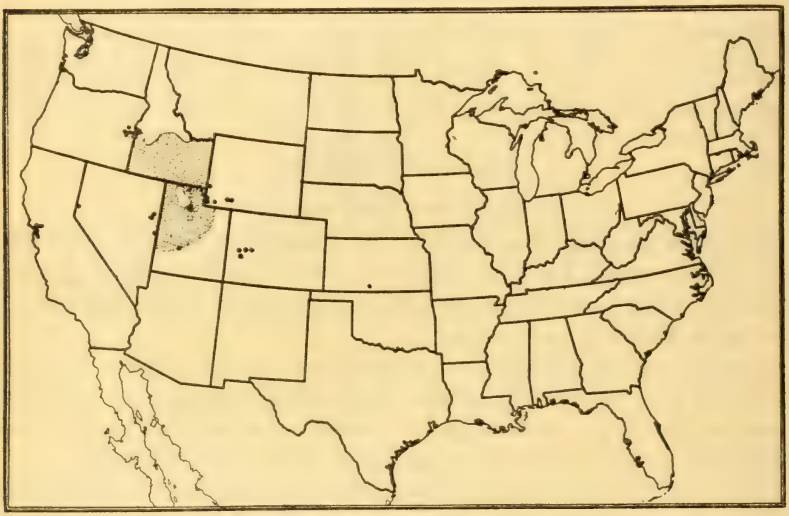

FIG. 9.—Geographical distribution of the alfalfa weevil in the United States in 1921: Shaded areas, generally infested; black dots, definite infested localities.

To the west, the Utah infestation has extended into Nevada, in the eastern third of White Pine County, and to the northwest this infestation has extended through Idaho into the northern part of Malheur County, Oreg.

Isolated outbreaks, probably the result of commercial transportation, have been discovered near the California State line in southern Washoe County, Nev., and in the east-central part of Colorado, in Delta, Montrose, and Gunnison Counties.

The weather conditions over the region infested by the alfalfa weevil show no excessive departures from the normal. The temperature during the fall of 1920 was slightly below normal, while the winter of 1920–21 was characteristically mild, the temperatures ranging between 3° and 4° F. above normal. April was generally cold,

while the remainder of the season was comparatively warmer. (See Table 5 and Fig. 10.)

The rainfall over this region was above normal during the fall and early winter. During the early spring slight droughts occurred during March. The remainder of the spring and summer were slightly above normal. September of 1921 showed a deficiency of about ½ inch. (See Table 5 and Fig. 10.)

Figure 9 illustrates the area known to be infested in 1921. The shaded area is generally infested and the black dots are definite localities where the pest has been collected.

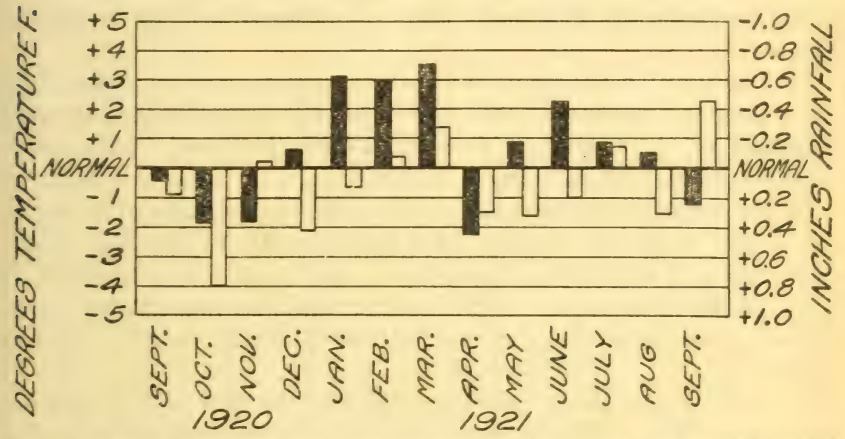

FIG. 10.—Monthly departures from normal temperature (solid black) and rainfall (white) from September, 1920, to September, 1921, inclusive, in the region infested by the alfalfa weevil. (See also Table 5.)

TABLE 5.—*Monthly departures from normal temperature and rainfall from September, 1920, to September, 1921, inclusive, in the region infested by the alfalfa weevil.*

DEPARTURES (IN DEGREES FAHRENHEIT) FROM NORMAL TEMPERATURE.

	1920				1921								
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Wyoming	−0.1	−0.5	−3.7	+1.4	+3.8	+5.1	+4.3	−2.6	+1.0	+3.3	+1.3	+0.8	−0.7
Idaho	+.0	−2.1	−.7	+2.3	+3.4	+.9	+2.8	−2.9	+1.2	+2.8	+.6	+1.0	−3.9
Oregon	−.3	−2.1	−1.2	+2.0	+1.5	+1.9	+1.8	−1.4	+.3	+2.2	−1.0	−.1	−2.3
Utah	−.4	−2.2	−.7	−.2	+3.7	+2.9	+4.0	−3.1	+.8	+2.1	+1.2	−.3	−.8
Colorado	−.9	−.7	−2.4	−2.8	+3.7	+3.6	+4.9	−2.3	+1.5	+.5	+.5	−.1	+1.1
Nevada	−.1	−2.7	−1.1	+.4	+2.6	+2.8	+4.0	−1.8	+.0	+2.2	+1.6	+.4	−.4
Regional mean	−.3	−1.7	−1.6	+.5	−3.1	+2.9	+3.6	−2.3	+.8	−2.2	+.7	+.3	−1.2

DEPARTURES (IN INCHES) FROM NORMAL RAINFALL.

Wyoming	−0.33	+0.28	−0.10	−0.08	−0.04	−0.48	−0.34	−0.19	+0.06	+0.36	−0.18	−0.27	−0.77
Idaho	+.29	+1.02	+.19	+.83	+.18	+.00	−.15	+.38	+.77	−.40	−.43	+.05	−.30
Oregon	+1.83	+1.35	−.19	+1.90	+.74	+1.31	−.21	+.19	−.02	−.08	−.50	−.23	−.01
Utah	−.26	+1.77	−.12	+.23	+.05	−.39	−.33	+.71	+.40	−.22	+.01	+.95	−.69
Colorado	−.27	+.32	−.09	−.24	+.05	−.47	−.10	+.72	−.39	+1.52	+.36	+1.17	−.97
Nevada	−.18	+.24	+.04	−.08	−.22	−.39	−.56	−.09	+1.12	−.05	−.16	+.09	−.22
Regional mean	−.18	+.83	−.05	+.42	+.12	−.07	−.28	+.28	+.32	+.18	−.15	+.29	−.49

SORGHUM WEBWORM.

(*Celama sorghiella* Riley.)

A very unusual outbreak of the sorghum webworm occurred in southern Missouri, southeastern Kansas, and western Arkansas. No reports were received from northwestern Oklahoma, but the pest undoubtedly occurred at least in the northwestern corner.

Celama sorghiella was described by Riley, from Citronelle, Mobile County, Ala., in 1882. Records of its occurrence have been made from south-central Texas, northward and eastward through southeastern Kansas, central Missouri, southern Indiana, northern Virginia, and central Maryland, thence southward to and including Florida.

In Arkansas the sorghum webworm outbreak was the outstanding entomological feature of the year, and the grain sorghums were damaged to the extent of from 25 to 100 per cent of the crop. Sixteen counties in the central and western part were infested.

In Missouri the outbreak was most serious in the strip of territory extending from the vicinity of Clinton south to Neosho or the Arkansas and Oklahoma State lines. Kafir corn was reported as being damaged to the extent of 50 per cent of the crop in some cases. Sixteen counties in the southern half of the State were reported as infested.

In Kansas this insect was reported for the first time attacking kafir corn. The outbreak was confined to five counties in the southeastern part. In some instances plantings were a total loss.

TABLE 6.—*Amount of sorghum and kafir-corn forage harvested in 1919 in five counties in Kansas infested with the sorghum webworm, and the amount and value of sorghum seed and kafir seed harvested.*

County.	Sorghum, kafir, etc., forage.[1]	Sorghum seed, 1919.		Kafir seed, 1919.	
		Quantity.	Value.	Quantity.	Value.
	Tons.	*Bushels.*		*Bushels.*	
Bourbon	15,016	6,698	$10,181	146,412	$187,407
Cherokee	12,795	5,552	7,772	81,054	102,938
Chautauqua	21,999	54,726	75,521	194,005	248,390
Greenwood	64,742	6,448	8,704	355,878	480,335
Labette	7,109	1,640	2,460	110,325	165,487
Total	121,661	75,064	104,638	887,674	1,184,557

[1] From 1920 census.
[2] From report of Kansas State Board of Agriculture.

	Bushels of seed.
Missouri	405,000
Arkansas	302,000
Kansas	963,000
Total	1,670,000

The relative importance of this pest can be estimated approximately from the available data on the quantity and value of this

crop in the infested territory during the season of 1919. Table 6 indicates the amount of sorghum and kafir corn forage harvested in the five counties in Kansas during the season 1919 according to the Fourteenth Census, and the number of bushels of sorghum seed and kafir seed harvested from the same counties during 1919, and the values of each, according to the figures given in the Twenty-second Biennial Report of the State Board of Agriculture of Kansas.

According to these figures it will be seen that in the five infested counties in Kansas over 121,000 tons of sorghum and kafir forage were harvested in 1919, while approximately 963,000 bushels of seed were harvested, valued at $1,289,000. By comparing these figures with the census figures for Missouri and Arkansas, it is seen that

FIG. 11.—Geographical distribution of the sorghum webworm in the United States: Shaded area, seriously infested in 1921; black dots, localities from literature.

over 1,500,000 bushels of this seed were produced in the infested counties in the three States during 1919. The lowest estimated damage in this territory amounted to 25 per cent of the seed.

The map (Fig. 11) indicates the area infested this year (shaded) and previous records of the occurrence of this insect (black dots).

The temperature in the region infested by the sorghum webworm was very uniform, the graphs of the three States showing marked similarity. The temperature throughout the entire season was characteristically above normal, the low temperatures of November being the only exception. The winter was extremely mild, ranging about 4° or 5° F. above normal, while the spring and summer were slightly above normal. (See Fig. 12 and Table 7.)

The rainfall in this region was also quite uniform in the three States, rainy periods occurring in March and April and decided

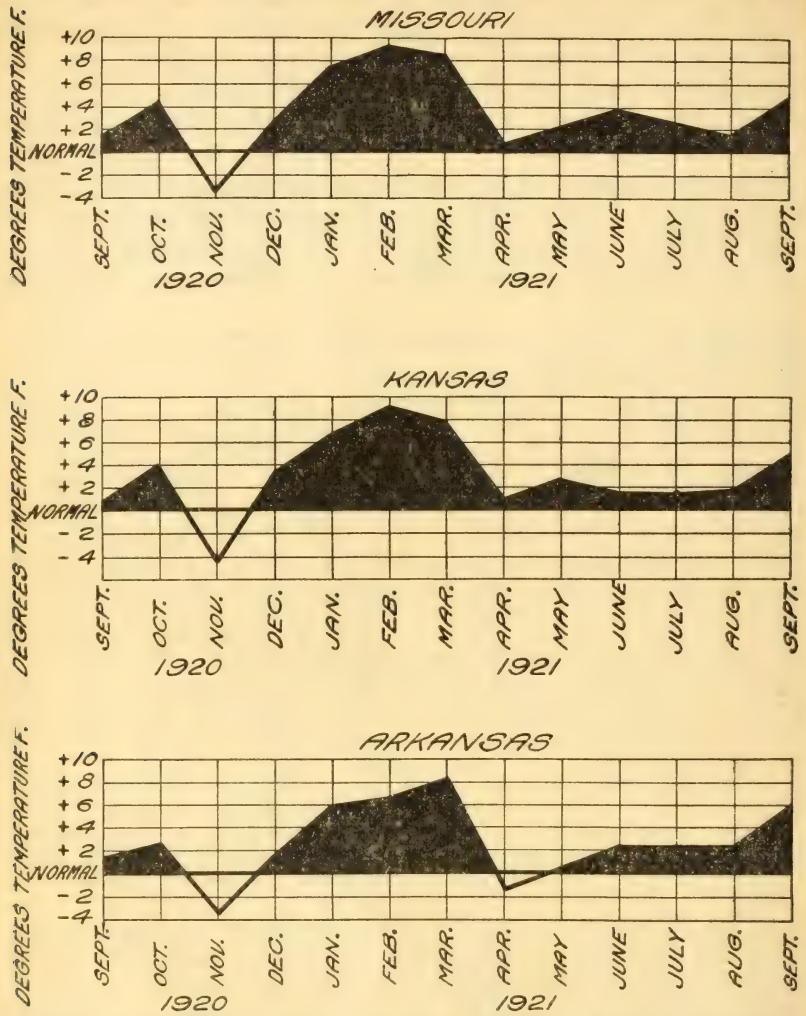

FIG. 12.—Monthly departures from normal temperature for the fall of 1920, the winter of 1920–21, and the growing season of 1921 in the region infested by the sorghum webworm during 1921. (See also Table 7.)

droughts in January, February, May, and July. (See Fig. 13 and Table 7.)

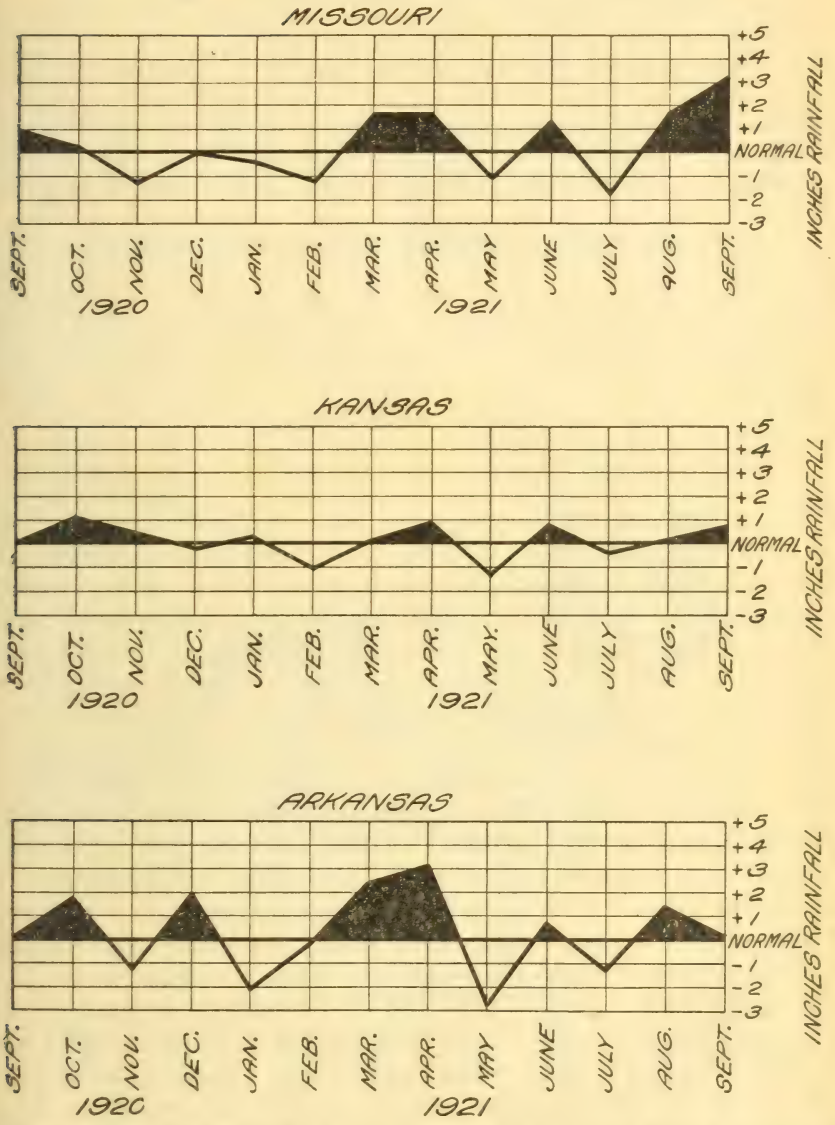

FIG. 13.—Monthly departures from normal rainfall for the fall of 1920, the winter of 1920–21, and the growing season of 1921 in the region infested by the sorghum webworm during 1921. (See also Table 7.)

TABLE 7.—*Monthly departures from normal temperature and rainfall for the fall of 1920, the winter of 1920–21, and the growing season of 1921 in the region infested by the sorghum webworm during 1921.*

DEPARTURES (IN DEGREES FAHRENHEIT) FROM NORMAL TEMPERATURE.

	1920				1921								
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Missouri	+1.4	+4.3	−3.5	+2.6	+7.2	+9.1	+8.5	+0.9	+2.0	+3.4	+2.9	+0.8	+4.7
Kansas	+.6	+3.8	−4.4	+3.2	+6.9	+9.0	+7.3	+.9	+2.4	+1.6	+1.1	+1.4	+4.6
Arkansas	+1.2	+2.2	−3.9	+1.2	+5.7	+6.3	+8.3	−1.1	+.7	+2.1	+2.2	+2.4	+6.0
Regional mean	+1.0	+3.4	−3.9	+2.3	+6.6	+8.1	+8.0	+.2	+1.7	+2.3	+2.0	+1.5	+5.1

DEPARTURES (IN INCHES) FROM NORMAL RAINFALL.

Missouri	+0.92	+0.25	−1.09	−0.22	−0.38	−1.33	+1.68	+1.52	−1.20	+1.15	−1.77	+1.63	+3.15
Kansas	+.22	+1.04	+.19	−.07	+.37	−1.01	+.06	+.72	−1.31	+.81	−.37	+.26	+.58
Arkansas	+.05	+1.68	−1.47	+1.92	−2.08	−.18	+2.10	+3.02	−2.83	+.60	−1.43	+1.40	+.03
Regional mean	+.40	+.99	−.79	+.54	−.69	−.84	+1.28	+1.75	−1.78	+.85	−1.19	+1.09	+1.25

EUROPEAN CORN BORER.

(*Pyrausta nubilalis* Hübn.)[4]

The outstanding developments in the corn-borer situation for 1921 were, first, the serious injury to field corn and the development of a much greater area of infestation than was believed to be present in the Province of Ontario, Canada; second, the discovery by Bureau of Entomology scouts of the presence of the insect along the entire southern shore of Lake Erie from the extreme western line of New York State through Pennsylvania and Ohio to southeastern Michigan, just south of the city of Detroit. The latter infestation is a very mild and uniform one and, so far as has been ascertained, does not extend far inland. No commercial injury whatever has been done in this area as yet; nevertheless, its establishment there becomes of great importance, as indicating that this insect is in a position to invade the area of most intensive corn production in this country. The conditions in the various other areas of infestation prevailing at the beginning of the spring of 1922 are as follows (Fig. 14):

The corn borer is known to be present throughout a total area of 7,696 square miles within the United States, as compared with an area of 7,690 square miles in Ontario, Canada. The area of infestation in eastern New England comprises 2,670 square miles. The spread there during the past year has been comparatively small, and in every case is contiguous to the area of infestation as known in 1920. A very small incipient infestation discovered during the summer of 1920 in the township of Eliot, Me., was cleaned up and

[4] Reported by W. R. Walton, Bureau of Entomology.

did not appear during the summer of 1921, but as the southwestern corner of that State is in the direct path of the natural spread of the insect, it may be expected that this territory will become infested by natural means in the immediate future. The infestation prevailing in corn in the most intensely infested part of the old area of infestation in Massachusetts is practically unchanged. On the other hand, a considerably higher degree of infestation has occurred in the case of other cultivated crops, including especially vegetables and flowers. It is estimated that the loss to corn in this heavily infested area as a direct result of the injury of the insect ranged from 8 to

FIG. 14.—Geographical distribution of the European corn borer in the United States and Canada in 1921, shown by black areas.

20 per cent of the total value of the crop. Outside of this heavily infested area and in some fields within it, little or no commercial damage has as yet occurred to the ears of either sweet or field corn.

In the eastern New York area in the vicinity of Schenectady and Albany, the infested area comprises 2,203 square miles. The commercial injury here has as yet been almost negligible. Not more than 1 per cent of the ears of corn from infested fields were discarded as unmarketable on account of corn-borer injury. The degree of infestation in sweet corn in this area was slightly greater than in 1920. In western New York, in the vicinity of Buffalo and Dunkirk, an area which is now continuous with the infested areas in

Pennsylvania, Ohio, and Michigan, the total infestation comprises 1,634 square miles in New York, 347 square miles in Pennsylvania, 757 square miles in Ohio, and 85 square miles in Michigan. The commercial loss to the corn crop in the western New York area as yet has been comparatively slight. The average infestation of field corn here was slightly greater than in the preceding year. Of the most heavily infested fields, 17 showed an average stalk infestation of 32 per cent, and an average of two borers per infested stalk.

Six fields of sweet corn representing maximum infestation in this area showed an average of three borers per infested stalk, and a stalk infestation averaging 33 per cent. Commercial damage throughout the area, however, was very slight.

With the exception of the newly infested area along the southern shore of Lake Erie, the rate of natural spread previously observed, i. e., about 6 miles per year, has not been exceeded in any of the principal areas of infestation in the United States. It is suspected that the slight uniform infestation along the shore of Lake Erie was caused by a forced migration of the moths across the lake from the intense area of infestation prevailing in the neighborhood of St. Thomas, Ontario. Records of the Weather Bureau observation stations on the southern shore of the lake show that for the first time in five or six years the winds prevailing during the flight season of the moths blew from north or northeast for several days at a time. There is, of course, the possibility that this infestation may have been caused by the drift of infested material from across the lake, but as yet no traces of the presence of such material have been discovered on the southern shore of Lake Erie, and, furthermore, the uniform character of this mild infestation is believed to indicate some other means of dissemination. In an attempt to solve this phase of the problem the bureau has requested the permission of the Lighthouse Service to station observers during the flight season of the moths at several of the powerful lights maintained on the southern shore in order to ascertain whether corn-borer moths are attracted by these lights.

During April, 1922, the Bureau of Entomology established a field laboratory at Sandusky, Ohio, where a small corps of observers was stationed for the purpose of observing the insect and its progress of infestation. Additional plans for the combat of the insect include the maintenance of the quarantines throughout the infested areas, the scouting of all suspected territory, and the issuance of a new Farmers' Bulletin giving the practical results of investigations carried on by the bureau during the past three years. This will be followed by a professional paper containing all important technical details of the work.

CAMPHOR SCALE.

(*Pseudaonidia duplex* Ckll.)[5]

The camphor scale was first discovered in the United States at New Orleans in August, 1920, by E. R. Barber of the Bureau of Entomology. At that time it appeared to be infesting only the plants within a few blocks of the M. Cook nursery. It seems possible that this insect had been introduced on a Japanese rose through a Los Angeles nursery. In April, 1921, the infestation was surveyed and was then found to cover 27 city blocks. In early May a hurricane blew the young crawlers long distances in all directions, and in one case they were found, after the storm, nearly 2 miles from the center of infestation. During the summer the city of New Orleans and the State of Louisiana appropriated $33,000 in an effort to control the spread of this pest, which was threatening the camphor trees, one of the most beautiful landscape features of New Orleans. With these funds an effort was made to hold the pest to an area of about 4 square miles, and during this campaign more than 600 isolated infestations in various parts of the city were cleaned up.

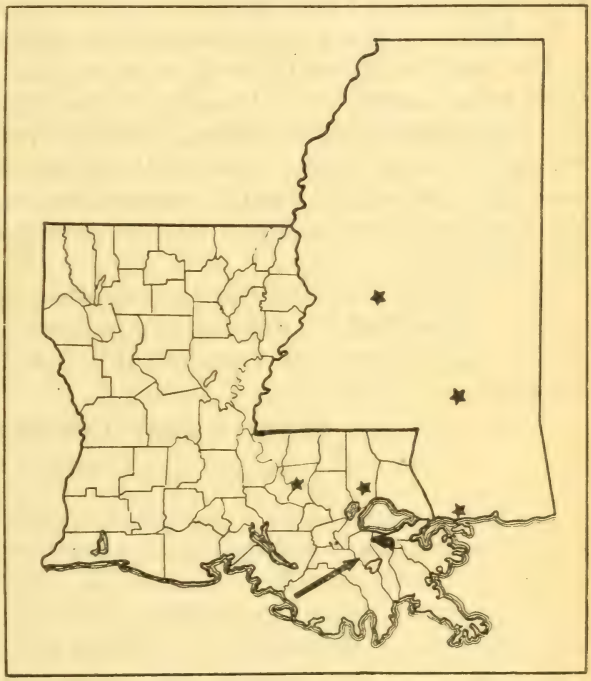

FIG. 15.—Geographical distribution of the camphor scale in the United States in 1921: The black area indicates the New Orleans infestation; the stars indicate areas where the scale has been found and eradicated.

On July 18, 1921, this insect was discovered for the first time in Mississippi at Hattiesburg on plants that were traced to shipments from New Orleans, made two years previously. The State plant board immediately took this outbreak in hand and condemned and burned all infested plants. On August 13, another infestation was located in Mississippi at Jackson, this also being traced to material

[5] From reports of E. R. Barber, R. W. Harned, and T. H. Jones.

shipped from New Orleans, and similar radical methods for the eradication of the pest were undertaken here.

The first record of this pest in Louisiana, outside of the city of New Orleans, was made on September 23, 1921, when complaint was made of an outbreak in Victory Park, Baton Rouge, on *Camellia japonica*. The plants had been set out in the park about a year before and came from New Orleans. Another record of this pest in Louisiana was made on December 4, when specimens were sent to the agricultural experiment station from Hammond.

During November two new infested localities were discovered in Mississippi, one at Pass Christian and the other at Biloxi.

In January, 1922, a most discouraging discovery was made. Up to this time the successful eradication work in Mississippi and the work being carried on in the city of New Orleans gave hope that this pest might be exterminated. Then the pest was discovered infesting the large swamp area north of the city of New Orleans, covering a territory of about 10 square miles, making it very improbable that it will ever be destroyed. Its present distribution is shown in Figure 15.

The camphor scale has been found infesting a large variety of plants. Upward of 150 different species have already been recorded as food plants, some of them casually, but a large number very intensively.

MEXICAN BEAN BEETLE.

(*Epilachna corrupta* Muls.)[6]

The Mexican bean beetle was originally confined to the region lying west of central Texas and south of the northern border of Colorado, including Arizona and New Mexico. In 1920 it was discovered in the Birmingham region in Alabama. Survey work was instituted that year and the distribution was found to cover all of Jefferson, Shelby, and St. Clair Counties, the greater part of Etowah, Dekalb, Blount, and Bibb Counties, the eastern half of Tuscaloosa County, and the adjacent parts of Walker, Cullman, Marshall, Cherokee, Calhoun, Talladega, and Chilton Counties.

Federal quarantine was instituted on May 1, 1921, for the infested area and survey work carried on through the season of 1921. By July 26, 1921, the infested area was found to be so extensive that practical quarantine was impossible and the quarantine was raised. At the present time this beetle is known to infest the northern half of Alabama, the northern fourth of Georgia, the eastern third of Mississippi, and the extreme western corners of North Carolina and South Carolina.

[6] From reports of J. E. Graf, N. F. Howard, and others, Bureau of Entomology.

The area in Alabama is now bounded on the west by a line extending through the northwestern corner of Limestone County, through the center of Colbert County to the eastern border of Pickens County, thence southeastward to the northern border of Hale County, and eastward along the northern boundary of Perry County, extending thence southward into the northern arm of Dallas County, and eastward through southern Chilton and Coosa Counties, northern Tallapoosa County, and the southern border of Randolph County.

The infested area in Georgia extends southward to a line starting at the southern border of Heard County, extending southeastward into the northern corner of Troup County, thence northward through the eastern border of Carroll County and eastward across the center of Cobb County and the northern part of DeKalb County to the northern border of Wilkes County, thence in a northwesterly direction through the center of Madison and Banks Counties and northeastward to the center of Stevens County.

In Tennessee the infested area is bounded by a line extending from the southeastern corner of Giles County, northeastward through the center of Lincoln and Moore Counties, and northward across Coffee and Cannon Counties, and eastward to the northwestern corner of White County, thence across the southeastern corner of Putnam and Overton Counties, along the western boundary of Fentress County and the northern part of Scott County, and into Kentucky. It again returns into the State in Campbell County and runs eastward through Union and Grainger Counties, to the easternmost point in Hamblen County; the line then extends southwestward along the southern border of Hamblen County across the center of Jefferson County and the eastern quarter of Sevier County to the southeastern corner of the State.

The northmost part of the Tennessee infestation is continuous with a very small area in southern McCreary and Whitley Counties, Ky.

The area in South Carolina extends across Oconee and Pickens Counties and into Greenville County, and the area in North Carolina includes the greater part of Cherokee and Clay Counties.

The shaded area on the map (Fig. 16) is the area in the East known to have been infested in 1921. The solid-colored area was known to have been infested in 1920. The dots indicate localities from which this insect has been recorded in literature.

Table 8 and Figure 17 contain data on the departures from the normal temperature and rainfall in 1920–21 in the region infested by the Mexican bean beetle.

FIG. 16.—Geographical distribution of the Mexican bean beetle in the United States: Solid-colored area, known to have been infested in 1920; shaded area, known to have been infested in 1921; black dots, localities from literature.

TABLE 8.—*Monthly departures from normal temperature and rainfall from September, 1920, to September, 1921, inclusive, in the region infested by the Mexican bean beetle.*

DEPARTURES (IN DEGREES FAHRENHEIT) FROM NORMAL TEMPERATURE.

	1920				1921								
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Alabama	+1.7	+0.4	−2.9	−1.0	+4.1	+3.4	+7.7	−0.8	−0.7	+2.9	+1.5	+0.9	+6.2
Georgia	+1.5	−.2	−1.6	+.2	+3.1	+3.9	+7.7	+.2	−1.9	+2.0	−.2	−.2	+6.2
Tennessee	+1.3	+2.1	−2.4	+1.5	+4.3	+5.1	+10.0	+.9	−.3	+3.8	+2.9	+.4	+6.6
South Carolina	+1.5	+.5	−1.5	−.2	+1.3	+2.4	+7.5	+1.0	−3.1	+1.7	−.2	−.6	+5.8
North Carolina	+1.9	+1.2	−.1	+1.3	+1.4	+3.2	+8.9	+2.6	−2.8	+1.8	+1.1	−.3	+6.6
Regional mean	+1.6	+.8	−1.7	+.4	+2.8	+3.6	+8.3	+.8	−1.7	+2.4	+1.0	+.0	+6.3

DEPARTURES (IN INCHES) FROM NORMAL RAINFALL.

Alabama	−0.71	−1.54	+0.07	+2.92	−1.65	+0.04	−0.91	+2.05	−1.96	−2.18	−0.34	−0.48	−0.76
Georgia	+.05	−1.87	+1.12	+1.31	−.96	−.54	−3.21	−.22	+.72	−2.00	+1.13	−.95	−1.44
Tennessee	+.83	−1.60	−.72	+.31	−1.56	+1.21	+.09	+.46	−1.78	−1.66	+.15	+1.50	+1.33
South Carolina	+1.48	−2.29	+1.34	+.60	+.39	+.37	−1.58	−.48	+1.79	−2.08	+1.50	−1.94	−.51
North Carolina	+.95	−2.54	+2.33	+1.93	+.45	+.22	−1.50	+.51	+.41	−2.08	−.57	−2.45	−1.03
Regional mean	+.52	−1.96	+.82	+1.41	−.66	+.26	−1.42	+.46	−.16	−2.00	+.37	−1.26	−.48

SWEET-POTATO WEEVIL.

(*Cylas formicarius* Fab.)[7]

The sweet-potato weevil is known to occur in all of the Gulf States and the southern part of Georgia. East of the Mississippi River the

[7] From report submitted by F. H. Chittenden and others, Bureau of Entomology.

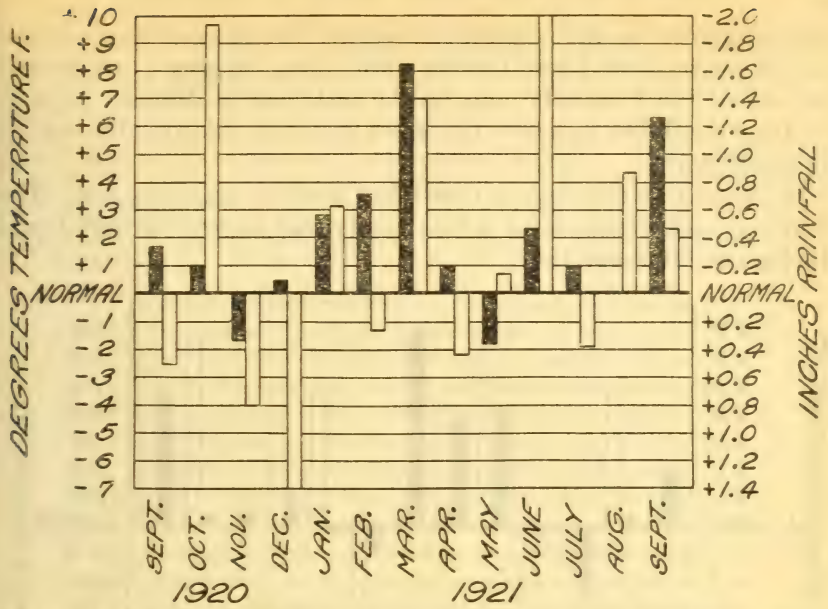

FIG. 17.—Monthly departures from normal temperature (solid black) and rainfall (white) from September, 1920, to September, 1921, inclusive, in the region infested by the Mexican bean beetle. (See also Table 8.)

outbreaks have been confined for the most part to the coastal region. In Louisiana and Texas, however, the area infested is much more extensive, covering the greater part of these States. (See Fig. 18.)

In Florida eradication work is being attempted at two points, one in Baker County and the other at Arcadia in De Soto County. The

FIG. 18.—Geographical distribution of the sweet potato weevil in the United States in 1921, shown by black areas.

pest is known to be present throughout the greater part of the coastal region from Pasco County south along the west coast around the end of the Peninsula, and up the east coast to Volusia County. On the coastal line, however, the insect is mainly infesting the seaside morning-glory.

In Georgia an outbreak in Charlton County is under control. The work has been so successful in this county that no weevils were found during the fall inspection.

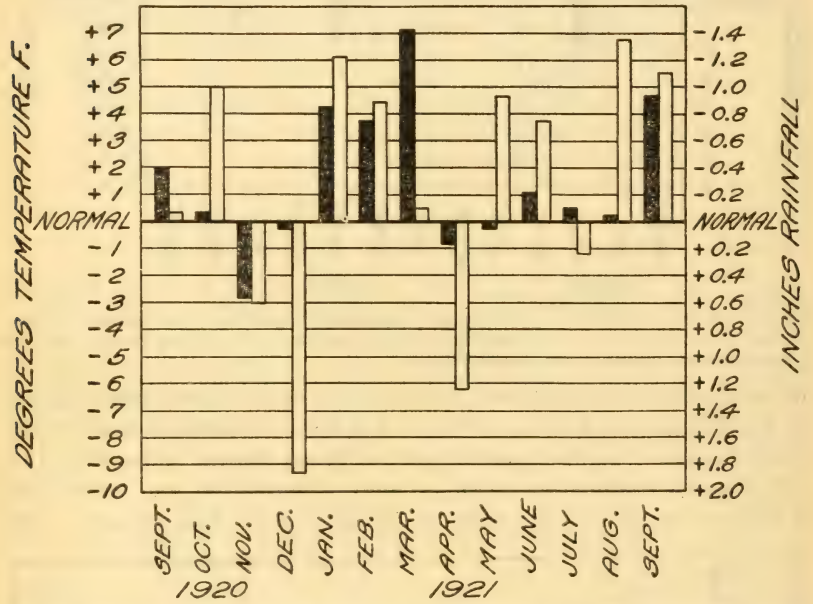

FIG. 19.—Monthly departures from normal temperature (solid black) and rainfall (white) from September, 1920, to September, 1921, inclusive, in the region infested by the sweet-potato weevil. (See also Table 9.)

In Alabama the original infestation has probably been eradicated, but the fall inspection disclosed a new though small infestation along the coast in Mobile County.

In Mississippi an attempt is being made to eradicate the weevil from the four coast counties. Substantial progress has been made in Pearl River, Hancock, and Harrison Counties, but the work is being delayed in Jackson County on account of inadequate force. No eradication work is being attempted west of the Mississippi River, and in this area the weevil is slowly extending its range northward. At the present time it has been reported in the vicinity of Shreveport, La., as well as in two counties in southern Oklahoma. Should the latter report be verified it will mark the first infestation north of the Red River.

Data on the departures from normal temperature and rainfall in 1920–21 in the region infested by the sweet-potato weevil are given in Figure 19 and in Table 9.

TABLE 9.—*Monthly departures from normal temperature and rainfall from September, 1920, to September, 1921, inclusive, in the region infested by the sweet-potato weevil.*

DEPARTURES (IN DEGREES FAHRENHEIT) FROM NORMAL TEMPERATURE.

	1920				1921								
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Texas	+1.8	+0.5	−2.9	+0.5	+5.7	+3.6	+5.6	−1.8	+0.6	−0.8	+0.0	+1.7	+4.0
Louisiana	+2.5	+.5	−4.2	+.4	+5.8	+4.3	+7.8	−1.2	−.8	+.2	+.8	+1.7	+4.2
Mississippi	+2.6	+1.0	−4.2	−.1	+5.1	+4.2	+8.4	−1.3	−.4	+1.9	+1.7	+1.9	+5.9
Alabama	+1.7	+.4	−2.9	−1.0	+4.1	+3.4	+7.7	−.8	−.7	+2.9	+1.5	+.9	+6.2
Georgia	+1.5	−.2	−1.6	+.2	+3.1	+3.9	+7.7	+.2	−1.9	+2.0	−.2	−.2	+6.2
Florida	+.6	−1.8	−1.1	−.8	+2.0	+3.0	+5.4	+.4	+2.2	+.7	−.7	+.3	+2.7
Regional mean	+1.8	+.1	−2.8	−.1	+4.3	+3.7	+7.1	−.7	−.1	+1.1	+.5	+1.0	+4.8

DEPARTURES (IN INCHES) FROM NORMAL RAINFALL.

Texas	−0.65	+1.20	+0.27	−0.66	+0.04	−0.29	+0.82	+0.46	−1.74	+3.39	−0.42	−1.60	+1.20
Louisiana	−.02	+.20	+.55	+4.10	−1.27	−2.28	+1.35	+1.77	−1.54	+.55	+.35	−2.08	−.74
Mississippi	−.19	−1.21	−.02	+3.11	−2.00	−.66	−2.64	+4.09	−3.00	−1.43	−.51	−.66	−.33
Alabama	−.71	−1.54	+.07	+2.92	−1.65	+.04	−.94	+2.05	−1.96	−2.18	−.34	+.48	+.76
Georgia	+.05	−1.87	+1.12	−1.31	−.96	−.54	−3.21	−.22	+.72	−2.00	+1.13	−.95	−1.44
Florida	−1.32	−2.75	+1.83	−.63	−1.49	−1.56	−1.16	−.58	+1.95	−2.74	+1.43	−2.32	−4.53
Regional mean	−.03	−.99	+.63	+1.90	−1.22	−1.04	−.08	+1.26	−.93	−.73	+.25	−1.02	−.86

POTATO LEAFHOPPER.

(*Empoasca mali* LeB.)

During the year the potato leafhopper was seriously destructive over a large part of the commercial potato-growing region of the United States, and Mr. Gibson, Dominion entomologist, reports it as the most destructive potato pest during this season in Canada. The association of this insect with potato tipburn ("hopperburn") has stimulated interest in the depredations of this pest. Part of the distribution areas on the accompanying map (Fig. 20) were obtained from the survey reports of the plant disease survey, Bureau of Plant Industry.

The most serious infestations were in the North-Central and East-Central States. In Illinois the leafhopper caused considerable loss to potatoes over the entire State, except where these were protected by Bordeaux spray. Serious injuries were also reported from the northern half of Indiana and the central part of Ohio. The insect was also seriously abundant throughout the entire potato growing sections of Minnesota, Wisconsin, and Michigan.

In North Dakota outbreaks were recorded from the southeastern part of the State, extending from Grand Forks County to Dickey

County and eastward. In South Dakota the infested region was continuous with that in North Dakota, extending westward to the middle of McPherson County through Hand County to Charles Mix County. By the middle of July in South Dakota many of the potato fields were practically dead as a result of "hopperburn."

In Iowa this insect was recorded as being one of the principal causes of low yields of potatoes. At Oelwein, in Fayette County, the crop was almost a complete failure.

In the New England and Middle Atlantic States quite serious infestations were recorded from eastern Vermont and western New Hampshire, along the Connecticut River Valley, the infestation being continuous with that extending through central Massachusetts

FIG. 20.—Geographical distribution of the potato leafhopper in destructive numbers in the United States in 1921, shown by shaded areas. Dots are localities of very severe infestation; circles, localities from literature.

and the greater part of Connecticut and Rhode Island. A similar infestation extended along the western side of Vermont, running parallel with the Hudson River Valley infestations in New York.

In New York serious outbreaks were recorded from central and western sections, Long Island, and Ulster County, very severe infestations being recorded from Chautauqua, Genesee, Wayne, Steuben, Onondaga, Ulster, and Suffolk Counties.

In Pennsylvania serious outbreaks were recorded up the Susquehanna River Valley.

West Virginia recorded an outbreak in the Ohio River Valley continuous with that in Ohio, and also recorded that this insect was much more abundant than usual in Tucker County.

Isolated reports were received from Buncombe County, N. C., Buchanan County, Mo., and Oktibbeha, Lauderdale, and Copiah Counties, Miss.

The map in Figure 20 indicates, by shading, the area of serious infestation. The black dots indicate reports of definite localities where exceptionally serious damage was sustained during 1921, while the circles indicate localities from which reports of outbreaks have been received in previous years.

SEED-CORN MAGGOT.

(*Hylemyia cilicrura* Rond.)

During the past season a rather remarkable outbreak of the seed-corn maggot attacking the seed pieces of early planted potatoes occurred along the Atlantic seaboard.

FIG. 21.—Map indicating sequence of reports of destructive abundance of the seed-corn maggot in the United States in 1921.

Early in April the first report was received from North Carolina, the outbreak being reported as both severe and extremely unusual, 50 per cent of the early planted crop in the Beaufort district having been destroyed, many of the fields so seriously damaged as to necessitate replanting, and others abandoned. The infested area included the region bounded by a line extending along the northern border of Dare and Tyrrell Counties, across the center of Bertie and southeastern corner of Halifax Counties, thence southward across Edgecombe and Wilson Counties, the western third of Greene County, the middle of Lenoir County and eastward across the upper third

of Jones County, the south shore of Pamlico County, and the northern part of Carteret County.

This was followed about the middle of April by reports coming in from Norfolk and the eastern-shore districts of Virginia. In this State both the entomologist and the plant pathologist were inclined to believe that the seed-corn maggot was of secondary importance and that the chief damage was being occasioned by a Fusarium disease.

By April 21 serious reports were coming in from the eastern shore of Maryland and the southern half of New Jersey, where by actual count 10 per cent of the seed pieces were damaged to such an extent that the plants failed to develop properly. By May 1 this outbreak had become so serious that 20 per cent of the hills were missing in the infested fields. In this State it also did serious damage to pea and bean seeds and lettuce plants.

Early in May potato seed pieces were being attacked on Long Island, but here the outbreak was not at all serious.

About May 10, reports were received from Massachusetts that this insect was seriously attacking the onion plantings in the Connecticut River Valley, some fields suffering 25 per cent damage, and the last report of the season was received from Maine on June 16, where this insect was recorded as damaging the underground stems of beans.

The early potato planting season along the Atlantic coast was characterized by hot and dry weather. Germination was slow and conditions were possibly advantageous for the development of certain fungous diseases which, undoubtedly, were associated with the depredations of, if not responsible for the damage attributed to the seed-corn maggot.

One of the most interesting features of the survey reports on this insect were the independent reports from Maryland, Massachusetts, and New Jersey, that infestations were far worse on fields where meat scrap or fish scrap fertilizers were used. These reports indicate that organic fertilizers of this class are attractive to the adult seed-corn maggots.

Figure 21 indicates the sequence of reports received relative to the destructive abundance of this pest along the Atlantic seaboard in 1921.

The correlation of the weather conditions with insect outbreaks was most forcefully illustrated during the past season by the very unusual outbreak of this pest. The weather over the infested region was characterized during the late winter and early spring by very decided excesses of temperatures, January showing an excess of nearly 3° F, February of 4½°, March of 10°, and April of 5½°. This was accompanied by marked deficiencies in rainfall during

these months. In May throughout this region the weather suddenly changed, this month showing a deficiency in temperature and an excess in rainfall. The warm, dry weather of the early spring facilitated seeding and the greater part of the crop was planted early. The continued warm, dry weather interfered with germination and was very favorable for the heavy infestation of the seed pieces by this insect. The cold, wet weather of May started germination and terminated the erstwhile serious infestation of seed-corn maggots. Later plantings were not infested.

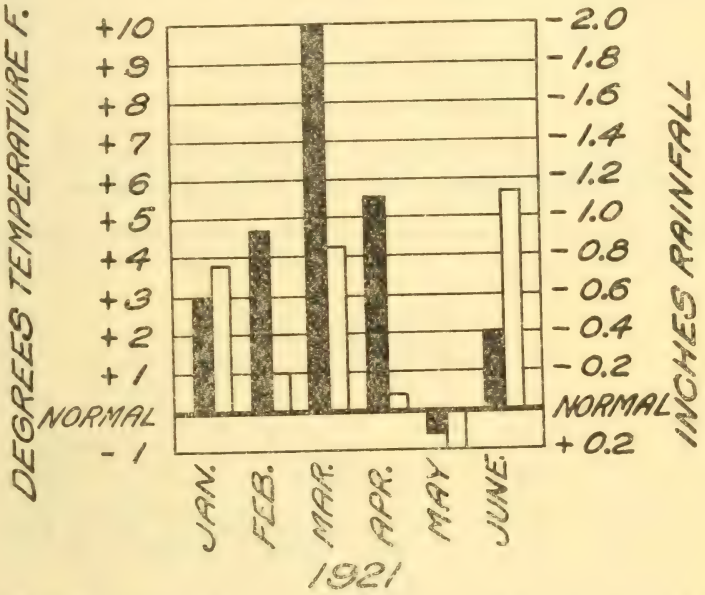

FIG. 22.—Monthly departures from normal temperature (solid black) and rainfall (white) in the region infested by the seed-corn maggot, January to June, inclusive, 1921. (See also Table 10.)

Figure 22 and Table 10 give data on departures from normal temperature and rainfall in 1921 in the region infested by the seed-corn maggot.

TABLE 10.—*Monthly departures from normal temperature and rainfall in the region infested by the seed-corn maggot, January to June, inclusive, 1921.*

DEPARTURES (IN DEGREES FAHRENHEIT) FROM NORMAL TEMPERATURE IN 1921.

	January.	February.	March.	April.	May.	June.
New England	+3.4	+3.5	+9.4	+5.6	+0.8	+0.0
New York	+2.7	+5.4	+9.8	+7.6	+1.6	+1.6
Pennsylvania	+3.1	+5.5	+10.8	+6.7	−.6	+2.7
New Jersey	+3.0	+4.4	+10.3	+6.8	−.2	+1.8
West Virginia	+3.3	+5.4	+10.0	+4.1	−.7	+3.2
Maryland and Delaware	+3.1	+5.0	+11.3	+5.5	−1.6	+2.2
Virginia	+2.2	+4.6	+10.6	+4.7	−2.7	+1.5
North Carolina	+1.4	+3.2	+8.9	+2.6	−2.8	+1.8
Regional mean	+2.7	+4.6	+10.1	+5.4	−.7	+1.8

TABLE 10.—*Monthly departures from normal temperature and rainfall in the region infested by the seed-corn maggot, January to June, inclusive, 1921*—Continued.

	DEPARTURES (IN INCHES) FROM NORMAL RAINFALL IN 1921.					
New England	−1.48	−0.55	−0.64	+0.77	−0.76	−0.53
New York	−1.29	−.26	+.30	+.45	−1.41	−.83
Pennsylvania	−.66	−.26	−.19	−.23	+.26	−1.18
New Jersey	−1.03	+.25	−.86	−.11	+.21	−.30
West Virginia	−.99	−.45	−.87	−1.00	+.45	−.44
Maryland and Delaware	−1.02	−.35	−1.25	−.18	+1.73	−1.54
Virginia	−.12	−.20	−1.71	−.44	+.76	−2.03
North Carolina	+.45	+.22	−1.50	+.51	+.41	−2.08
Regional mean	−.76	−.20	−.84	−.02	+.20	−1.11

COTTON BOLL WEEVIL.

(*Anthonomus grandis* Boh.)[8]

The mild winter of 1920–21 and the wet summer of 1921 favored an abnormal multiplication of the boll weevil throughout the terri-

FIG. 23.—Increase in area infested by the cotton boll weevil in the United States from 1892 to 1921 in 10-year periods.

tory infested by this insect. The weevil has now reached the limit of cotton cultivation, except in western Texas, southwestern Oklahoma, northeastern North Carolina, and Virginia.

For the first time Missouri and Kentucky were invaded by the weevil, and all fields in these States were found to be infested.

The gain west of the Mississippi River is very nearly equal to that east of the Mississippi River. The greatest gain in a single State,

[8] Extracted from Department Circular 210, by B. R. Coad, E. S. Tucker, W. B. Williams, F. F. Bondy, and R. C. Gaines.

however, is 15,700 square miles in North Carolina. The gain in Texas was over 10,000 square miles which practically extends the line to that of 1915, the territory lost by the weevil since that year being thus regained.

In Oklahoma almost the entire cotton area is infested, while practically the same condition prevails in Arkansas.

In Tennessee several new counties were invaded in the western portion along the Mississippi River Valley.

The entire areas of cotton production in Georgia and South Carolina are totally infested. Altogether 66,662 square miles of new territory were invaded by the weevil in 1921, and there was no loss of territory at any point. This makes a total of 600,771 square miles infested in the United States, leaving only about 105,000 square miles of cotton territory still uninfested.

The accompanying map (Fig. 23) shows the increase in infested territory by 10-year periods since 1892. More detailed information on this subject may be obtained from Department Circular 210, United States Department of Agriculture.

PINK BOLLWORM.

(*Pectinophora gossypiella* Saund.)[9]

Prior to the discovery of this pest in Ellis County in the fall of 1921, there were five areas or districts of infestation known in Texas, namely, those of Hearne, Trinity Bay, Pecos Valley, Great Bend, and El Paso; a district in the southwestern part of Louisiana covering Calcasieu, Jeff Davis, and Cameron Parishes; a region continuous with the El Paso region in Dona Ana County, N. Mex., and a region closely related to the Pecos Valley district at Carlsbad in Eddy County, N. Mex.

Of the older areas of infestation the Hearne area has been apparently freed from the pest and is a demonstration of what can be accomplished where adequate control is maintained for a period of years. The Trinity Bay region has been reduced to a single locality at Moss Bluff in the southern part of Liberty County, and the infestations at Shreveport and in southwestern Louisiana have apparently been eliminated.

The entire success achieved by the establishment of noncotton zones in the three parishes of southwestern Louisiana, as shown by the elimination of cultivated cotton and the complete nonrecurrence of the pink bollworm in volunteer or other chance cotton in the district during the two years the noncotton zones have been maintained,

[9] Extracted from summary prepared under the direction of Dr. W. D. Hunter, Bureau of Entomology, Nov. 26, 1921.

has led to a substitution of a regulated zone for the noncotton zone in that district for 1922.

Only two new centers of infestation have been located—five fields in the vicinity of Ennis in Ellis County and a field near Marilee in Grayson County, in Texas. It is believed that these outbreaks originated from the seed of the crop of 1920 shipped from Carlsbad, N. Mex., prior to the determination of the incipient infestation at that point.

The Pecos Valley, Great Bend, and El Paso districts are almost certain to be reinfested every year under any system of clean-up or control which involves the continuation of the growth of cotton, or until such cooperation with Mexico is obtained as will lead to the

FIG. 24.—Geographical distribution of the pink bollworm in the United States in 1921 (solid-colored areas) and areas previously infested but reported free in 1921 (shaded areas).

cleaning up of the land on the Mexican side of the River and the freeing of the railway traffic from infestation at some interior point in Mexico.

On the accompanying map (Fig. 24) the shaded areas were formerly infested but were reported as free from the pink bollworm in 1921. The solid black areas were known to be infested in 1921.

JAPANESE BEETLE.

(*Popillia japonica* Newm.)[10]

The Japanese beetle, a native of Japan, was introduced into the United States in Burlington County, N. J., prior to 1916, presumably in the grub stage in soil about the roots of perennial plants. It was

[10] From reports of John J. Davis, C. W. Stockwell, and C. H. Hadley.

first discovered by H. B. Weiss and E. L. Dickerson, about the middle of August, 1916, in a nursery near Riverton. An interesting coincidence is that this insect was first discovered about a quarter of a mile from the place where the San Jose scale was first discovered in the eastern part of the United States.

The rate of increase has been remarkable. In 1916 about a dozen beetles were found, while in 1919, in the same locality, one person could collect by hand from 15,000 to 20,000 beetles in a day, and as many as 250 larvæ to the square yard.

FIG. 25.—Geographical distribution of the Japanese beetle in the United States since its discovery in 1916.

The area infested in New Jersey is mainly a market-garden and fruit-growing section, with Philadelphia as its chief market, while in Pennsylvania it is largely a residential section with much less land given up to farming. A considerable number of greenhouses and nurseries fall within this infested area, some handling only cut flowers, while others have a varied line of plants, bulbs, and outdoor-grown stock.

The area infested in 1916 covered approximately 0.9 square mile south of Riverton, N. J.; in 1917 this area had increased to 2.7 square miles; in 1918, to 6.8 square miles; in 1919 it had reached the Dela-

ware River to the north, and to the south had extended to Merchantville, in Camden County, and covered 48.3 square miles. In 1920 the pest was discovered across the Delaware River in Philadelphia and Bucks Counties, Pa., and had extended up the Delaware River on the New Jersey side as far as Burlington. In 1920 the area infested had reached 103.3 square miles; in 1921 the pest had spread to the south in New Jersey into Gloucester County, and to Medford and North Hampton in Burlington County. In Philadelphia County, Pa., it had extended to Frankford and Bustleton, and had touched the southern boundary of Montgomery County, while to the northeast it had extended to Bristol in Bucks County. It is now known to cover a territory of 270.1 square miles. (Fig. 25.)

The areas given for 1916, 1917, and 1918 are not necessarily exact since the earlier surveys were more or less general. The areas indicated for 1919, 1920, and 1921, however, are quite accurate, since very careful scouting was carried on during these years.

Beetles were discovered at two isolated localities to the southwest in Philadelphia County, one near the Delaware River, southwest of Elmwood, and the other on the west shore of the Schuylkill River in Fairmount Park.

SATIN MOTH.

(*Stilpnotia salicis* L.)[11]

The satin moth is common in Europe and is mentioned briefly in the writings of many European entomologists. It is reported as common in England and Ireland, its range extending from Spain to eastern Asia and as far north as Norway. One authority states that it occurs from Lapland to the middle of Italy and from England to Peking, China.

About July 1, 1920, a crew of men employed by the metropolitan park department found a number of Carolina poplar trees located on the Fellsway at the Malden and Medford City line, just north of Boston, Mass., that were being defoliated. S. S. Crossman, of the Bureau of Entomology, identified the insect as the satin moth, and this identification was later confirmed by the United States National Museum.

Scouting was immediately started and, as a result of this work, by the fall of 1920 the insect was known to occur over an area of 642 square miles including 60 towns in Massachusetts and 4 in New Hampshire. Inasmuch as large larvæ and pupæ were found in many of the towns, these towns were evidently infested the previous year (1919). During the year 1921 this insect was numerous in several towns and cities about Medford and Malden, where plantings of poplar suffered almost complete defoliation. Beyond this central

[11] By A. F. Burgess, Bureau of Entomology.

area the infestation can be considered as only slight. Very little territory was added this year to that infested in 1920. Rockland township is the first township in Plymouth County to be infested. Needham and Millis were added to the two towns already infested in Norfolk County. Holliston is added to the infested towns in Middlesex County, and Rye is added to the towns infested in Rockingham County, N. H.

Reports of this insect were received through the office of blister rust control, Bureau of Plant Industry, from Westminster, British Columbia, where the moth was reported as established in a park where it was thought to have been introduced on soldiers' equipment from the Gallipoli Peninsula, as the soldiers were quartered in this park on their return from the Dardanelles. It is reported that 80 per cent of the moths in Canada were killed during the winter by a parasite.

FIG. 26.—Geographical distribution of the satin moth in the United States: Solid-colored area, known to have been infested in 1920; uncolored named towns, infested in 1921.

Arthur Gibson, Dominion entomologist, says:

> During the past summer the outbreak of this insect in British Columbia extended to Vancouver Island. At the present time the insect is permanently established on the mainland adjacent to Vancouver and New Westminster and on Vancouver Island at Duncans.

This insect threatens poplars and possibly willows over the whole area of its distribution. So far, however, only the poplars planted for shade have suffered severely. The species has attacked Lombardy, Carolina, and Balm of Gilead, and undoubtedly will attack practically all of the species of poplar. The favored species usually occur singly or in small plantings over the area infested by this in-

sect at present. This may have a considerable influence in lessening the ravages of this species.

Two of the introduced enemies of the gipsy moth are vigorously attacking this host, namely, *Compsilura concinnata* Meig. and *Calosoma sycophanta* L. These two enemies are undoubtedly responsible for the checking of the damage done by the satin moth. Three native tachinid flies are also commonly bred from the larvæ of the species—*Tachina mella* Walk., *Euphorocera claripennis* Macq., and *Winthemia quadripustulata* Fab. *Telenomus californicus* Ashm. has been reared from the eggs.

The solid area on the map (Fig. 26) indicates the region infested in 1920, while the uncolored named towns are the additional ones infested during 1921.

Table 11 gives the departures from normal temperature and rainfall in New England in 1920–21.

TABLE 11.—*Monthly departures of temperature and rainfall in New England for the fall of 1920, the winter of 1920–21, and the growing season of 1921, used in connection with the 1921 summary of the gipsy moth, the brown-tail moth, and the satin moth.*

DEPARTURE (IN DEGREES FAHRENHEIT) FROM NORMAL TEMPERATURE.

	1920				1921								
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
New England.....	+1.7	+6.2	−1.4	+2.9	+3.4	+3.5	+9.4	+5.6	+0.8	+0.0	+3.0	−1.5	+3.3

DEPARTURE (IN INCHES) FROM NORMAL RAINFALL.

New England.....	+2.00	−1.68	+1.09	+2.19	−1.48	−0.55	−0.64	+0.77	−0.76	−0.53	+1.10	−1.02	−1.12

GIPSY MOTH.

(*Porthetria dispar* L.)[12]

The gipsy moth, during 1921 and for a series of years preceding, has met with adverse conditions along its northern and northeastern borders of distribution. The weather conditions in the spring are usually favorable, when small larvæ are being carried by the wind, for its rapid dispersion in these directions, but the line of advancement is considerably impeded by the rapid change in the type of forest growth, the proportion of hardwoods to conifers changing rapidly. Large areas of practically clear coniferous growth are unfavorable to the development of larvæ, and such growth is found more or less in the regions mentioned above. Another serious obstacle in the more northern regions is the prevailing low tempera-

[12] By A. F. Burgess, Bureau of Entomology.

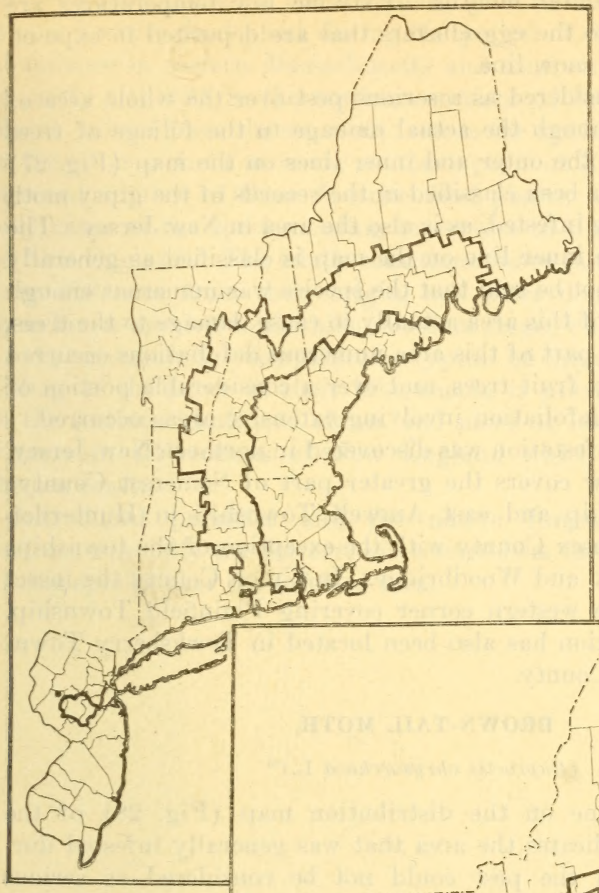

FIG. 27.—Geographical distribution of the gipsy moth in the United States: The inner line incloses the area of general infestation, while the area between the outer and inner lines and the area in New Jersey were only lightly infested in 1921.

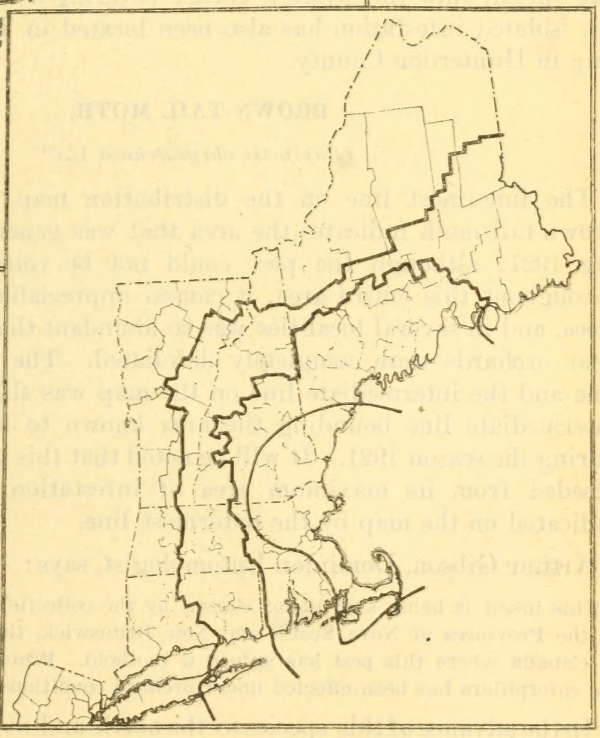

FIG. 28.—Geographical distribution of the brown-tail moth: The innermost line incloses the area of general infestation, the intermediate line limits the infestation of 1921, and the outermost line limits the infestation of 1914.

tures during the winter months. Extreme low temperatures are known to be fatal to the egg clusters that are deposited in exposed situations above the snow line.

The species is considered as a serious pest over the whole area of its distribution, although the actual damage to the foliage of trees in the area between the outer and inner lines on the map (Fig. 27) is but slight, and has been classified in the records of the gipsy moth laboratory as lightly infested, as is also the area in New Jersey. The area inclosed by the inner line on the map is classified as generally infested. It could not be said that the species was numerous enough in 1921 in all parts of this area actually to cause damage to the trees, but over the greater part of this area numerous defoliations occurred to forest, shade, and fruit trees, and over a considerable portion of this area complete defoliation involving extensive areas occurred.

During 1920 an infestation was discovered in northern New Jersey. This infestation now covers the greater part of Somerset County; Readington Township and east Amwell Township in Hunterdon County; and Middlesex County with the exception of the townships of Monroe, Madison, and Woodbridge. In Union County the insect has spread into the western corner covering Plainfield Township. An isolated infestation has also been located in Tewksberry Township in Hunterdon County.

BROWN-TAIL MOTH.

(*Euproctis chrysorrhoea* L.)[13]

The innermost line on the distribution map (Fig. 28) of the brown-tail moth indicates the area that was generally infested during 1921; although the pest could not be considered as serious throughout this entire area, it caused appreciable damage to fruit trees, and in several localities was so abundant that many apple and pear orchards were completely defoliated. The area between this line and the intermediate line on the map was slightly infested, the intermediate line bounding the area known to have been infested during the season 1921. It will be noted that this pest has materially receded from its maximum area of infestation attained in 1914, indicated on the map by the outermost line.

Arthur Gibson, Dominion Entomologist, says:

> This insect is being kept under control by the collection of the winter nests in the Provinces of Nova Scotia and New Brunswick, the only two provinces in Canada where this pest has gained a foothold. Practically no damage by the caterpillars has been effected under orchard conditions.

In the advance of this species to the north and northeast, conditions rapidly change with reference to its food plants. The pear, one of its

[13] By A. F. Burgess, Bureau of Entomology.

favorite food plants, is not commonly grown; the white oak, which was a favorite food plant during the period of the insect's greatest abundance in eastern Massachusetts and southern New Hampshire, is rarely met with in the northern sections of New Hampshire and Maine, inland from the sea coast; nor is the apple as common a tree in the latter sections as in the southern parts of New England. The lessened number of these favorite food plants, however, is not the only cause of the species failing to survive in the northern sections of New England. The adults sometimes move in tremendous flights, long distances from their origin, and after depositing their eggs their larvæ develop to the hibernaculum stage, where they are killed by the extremely low temperatures typical of these sections. Winter killing of the larvæ in their hibernacula is prevalent every winter in the sections mentioned above, and more or less so during severe winters in all sections of New England which are distant from the sea coast.

Introduced parasites and the native fungus *Entomophthora aulicae*, especially the former, are tremendous factors in the control of this species over the infested area.

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